J. Nelson Spaeth.

Vol. XXII November, 1924 No. 7

JOURNAL of FORESTRY

Published by the

Society of American Foresters

Single Copies 65c **Yearly $4.00**

Entered as second-class matter at the post-office at St. Paul, Minn., under the Act March 3, 1879. Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized November 20, 1918

Annual Meeting, December 30-31, Washington, D. C.

Society's Twenty-Fifth Anniversary.

JOURNAL OF FORESTRY

A professional journal devoted to all branches of forestry

EDITED BY THE EDITORIAL BOARD OF
THE SOCIETY OF AMERICAN FORESTERS

The JOURNAL appears eight times a year—monthly with the exception of June, July, August and September.

The pages of the JOURNAL are open to members and non-members of the Society.

Manuscripts intended for publication should be sent to Raphael Zon, Lake States Forest Experiment Station, University Farm, St. Paul, Minn., or to any member of the Editorial Board.

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THE INFLUENCE OF GROWTH CONDITIONS UPON THE PROPERTIES OF WOOD

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The relation between wood properties and the conditions surrounding the growth of the tree presents a field of study which as yet has been invaded by only a few investigators. The lack of progress is a result partly of the complex nature of an investigation of this kind and partly of the time required to obtain satisfactory results, besides the fact that in the United States a plentiful supply of timber has until recently made it possible to select material of high quality whenever it was needed for special purposes. It was in 1892 that Dr. B. E. Fernow, then Chief of the Forestry Division of the United States Department of Agriculture, first suggested a study of the problem.[1] With his background of study and experience in European forestry methods, Dr. Fernow was able to foresee the eventual need of such information in this country. He accordingly included a study of the influence of growth conditions in the program outlined when he organized the investigation which he called "Timber Physics, or the Science of Wood." His working plan contemplated a collection of field notes intended to furnish evidence upon the relationship between the various factors of environment and the quality of wood produced, but owing to interruption of the work on account of curtailment of funds his objective was never fully realized.

As time goes on the need for wood having exceptionally high qualities becomes more pronounced. With progressive exhaustion of virgin forests, attention is being centered upon younger stands as a source of the timber supplies needed. With certain exceptions, the

[1]Fernow, B. E., Timber Physics, Part I, Bulletin 6, Forestry Division, U. S. D. A., 1892.

lumber obtained from second-growth has usually been regarded as inferior in quality. Is it not time now to consider the whole subject of timber growing, from the standpoint of quality or usefulness of the lumber rather than from that of mere quantity production. It is the usefulness of the yield which will fix its final value, and this alone may largely determine the financial success of forest culture.

Empirical ideas concerning the influence of conditions of growth upon the strength of timber have been in vogue from time immemorial. One of the most interesting examples of history is recorded in connection with the building of the timber roof of Westminster Hall more than 500 years ago. The specifications for the timbers used in its construction designated not only the species of oak which should be secured but also stipulated that they should be selected from a forest growing on a heavy clay soil.

In this country today such ideas prevail widely. The contractor or manufacturer may be prejudiced against a species from a certain region. Preferences are often given material from the North rather than the South because of a general conception that northern-grown wood is superior. The true status of such opinions should be determined as having a direct bearing upon the forestry practice to be recommended.

The factors of growth which are considered as most likely to exert an influence upon wood properties include geographical location, elevation, temperature, rainfall, soil characteristics, growing space, and related conditions which go to make up the environment of a forest or a tree.

With so great a number of highly variable and interrelated factors working together, how is it going to be possible to determine which of the group may influence the bending strength, the hardness, or the toughness of a piece of wood?

The work of foreign investigators may give some idea of the complexity of the problem and of methods of attacking it. It is to be noted that their studies have dealt primarily with the influence of different factors upon the specific gravity of wood. Oven-dry specific gravity has been used as an index of technical quality, since it gives a measure of the actual wood substance contained in a piece of woody material.

The investigations of Robert Hartig[2] hold first place among the works of foreign investigators. His studies brought out several important relations between growing conditions and wood properties, from which he drew the following conclusions:

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[2]Hartig, R., "Holzuntersuchungen Altes Und Neues," Berlin, 1901.

1. That climate exerts no perceptible influence on the weight of the wood of red beech.
2. That the dry weight of wood increases with soil fertility.
3. That in the same stand differences exist between the wood of individual trees.
4. That the larger or smaller trees cannot be said to have the better wood.
5. That the width of the annual ring is no criterion for judging wood quality.
6. That, with certain exceptions, in the same pine stand the larger trees have the lighter and the smaller trees the heavier wood.
7. That wood of the greatest weight is found in the lower part of the bole and that it gradually diminishes in weight all the way up to the crown.

He formulated his conclusions into a system which he termed the "Nourishment Theory" (Ernährungs Theorie), wherein it is held that the quality of the wood produced is dependent upon the relation existing between fertility of the soil, transpiration of water by the crown, and assimilation. He asserts that the anatomical structure of wood conforms to the needs of the tree as brought about by external conditions; that the quantity of growth depends upon the total amount of foliage and the assimilative energy of the leaves, the latter function being affected by the quality of the soil, the illumination, and the temperature; while the weight (specific gravity) of wood is influenced by the proportionate quantity of conducting tissues to mechanical tissues. The greater the transpiration as compared with the production of wood substance, the greater the amount of porous tissues formed and the lighter the wood. Good heavy wood, therefore, arises when along with normal transpiration there results the most abundant assimilation possible.

Büsgen,[3] in 1897, in Chapter VIII of his textbook "Structure and Life of Our Forest Trees" discusses the weight and structure of wood. After considering the investigations of Hartig, Sanio, Omeis, and Bertog, he summarizes the "Present State of Experimental Research on the Influence of External Conditions Upon Wood Structure" by saying: "In this direction but very little has been done, although attention has for long been called to the dependence of anatomical relations upon environment." Cieslar,[4] also in 1897, published results of his studies

[3]Büsgen, M., "Bau und Leben Unserer Waldbaume," Jena, 1897.
[4]Cieslar, A., "Uber den Ligningehalt Einiger Nadelhölzer." Mittheilungen aus dem Forstlichen Versuchswesen Osterreichs, XXIII Heft, 1897.

of "The Influence of Geographic Habitat on Lignification of Spruce." He found that spruce grown in the optimum of its natural occurrence showed higher lignin content than when grown in the milder locations outside its natural limits of distribution, or at higher elevations. Again, in 1902,[5] Cieslar investigated the properties of rapidly growing spruce in contrast with slowly growing spruce, basing his study upon a comparison of material from two stands. A dominant, codominant, and suppressed tree were selected from each stand. In both cases he found that the more rapidly growing dominant spruce trees produced material lower in specific gravity than did the codominant. The suppressed tree in one case produced material of high specific gravity while in another case the wood from the suppressed tree was about equal to that of the dominant trees. He found that the higher specific gravity values corresponded to the wood which contained the greatest proportion of summerwood in the annual rings. Janka[6] made additional investigations upon the same trees with respect to the hardness of the wood. His work showed that the rapidly grown spruce wood was lower in hardness than that of slower or more normal growth.

In 1913[6] Janka investigated the technical character of larchwood. He could find no relation between rate of growth and specific gravity, but showed that the weight depended upon the relative proportion of summerwood.

These results do not furnish much practical or conclusive evidence, since the researches seem to have been rather sporadic and not in accordance with any well defined plan. They do, however, present an excellent illustration of the scope of the subject, its complexity, and the difficulties involved.

In the recent studies of the influence of growth conditions upon the properties of wood[7] conducted by the Forest Products Laboratory, the attendant difficulties have been fully recognized. In the beginning it seemed advisable to determine, if possible, whether any noteworthy differences in wood quality could be found on account of geographical location or site. Following the practice of foreign investigators and

[5]Cieslar, A. and Janka, G., "Studien über die Qualität rasch erwachsenen Fichtenholzes." I. Forstbotanischen Theil, von Dr. A. Cieslar. II. Technologischer Theil, von G. Janka. Mittheilung der K. K. Forstlichen Versuchsanstalt in Mariabrunn, Heft 8-9, 1902.

[6]Janka, G., "Jahrringbildung und Qualität des Fichtenholzes" Mittheilungen aus dem Forstlichen Versuchswesen Osterreichs, 1913.

[7]Paul, Benson H., "Influence of Growth Conditions Upon the Specific Gravity of White Ash." First progress report, 1923; Second progress report, 1924, Forest Products Laboratory, Madison, Wisconsin.

guided by the results of many tests conducted at the laboratory it was decided to use the specific gravity of the wood as an index of its quality, since the values for most wood properties increase with the specific gravity. Although not all properties increase in the same ratio, specific gravity offers a better criterion of wood quality than any other single determination. A study based on specific gravity was accordingly made of white ash representing widely different topographical and soil conditions ranging from those of the high slopes of the southern Appalachians to those of the alluvial overflow bottomland of the Mississippi delta. Specimens were collected from sites in North Carolina, western Tennessee, Arkansas, and northeastern Ohio.

Only a brief summary of the chief characteristics of the different sites can be included here. With the exception of a small amount of material from a white ash plantation on the Biltmore estate, Biltmore, N. C., the wood investigated came from representative trees in natural stands growing under conditions apparently normal for the species in the respective forest types.

The plantation mentioned is situated on the alluvial soil of the French Broad River bottom at an elevation of 2000 feet. The ground is level and is sometimes overflowed. The trees which were planted in 1903 range from 2 to 6 inches in diameter at the ground and from 20 to 35 feet in height. Those selected represented both rapid and slow growth, the former occupying the more open spaces. The specific gravity of the wood, however, did not seem to be influenced by the rate of growth of the trees. The chief difference found was between material near the ground and that from points higher in the same tree, the former being uniformly heavier.

The other site in North Carolina from which specimens were collected is a cove west of Mount Mitchell in the Pisgah National Forest, opening toward the west into Dillingham Valley. It contains forest growth of a typical chestnut-yellow poplar type with a number of other species intermingled, white ash occurring only sparingly and then only along or near water courses. The soil is a good moist loam of medium depth underlain by strata of mica and schist, and stones and rocks are not abundant except where uncovered by erosion along water courses. The trees selected ranged in age from 41 to 143 years and were growing at an elevation of 3,500 feet.

The material from this location represents upland white ash from moist but well drained sites. A stem analysis of the sections studied reveals slow growth of most of the trees during their early life. In all

cases, however, the narrow-ringed wood in the center of the boles is of excellent quality. The greatest variations in specific gravity occur between material from near the ground and that from points 16 feet or higher in the trees. The variations above the 16-foot point or from the center outward are not very great except in one tree which shows lower specific gravity values accompanied by much slower growth in diameter during the last 20 years.

Two sites were chosen for the collection of white ash in the vicinity of Memphis, Tenn. The first location was in the hardwood regional type of the rolling plateau near Germantown, 20 miles east of Memphis and the other in the Mississippi River bottom near Jeter, 20 miles north.

The first situation is about ½ mile south of the Wolf River, the ground sloping gradually northward and the soil consisting of a deep, well-drained, silty clay loam. The forest growth consists of red gum, yellow poplar, red oak, hickory, and elm, with a lesser stand of sycamore, white ash, and silver maple.

No timber had been cut from this area for a number of years. Groups of young second-growth trees existed in some places and open glades of grass in others. The presence of wire fences and general lack of undergrowth indicated that the forest was pastured continuously. The white ash trees found were of excellent form. The oldest tree cut was 181 years old. Five others, all between 90 and 100 years of age, were taken.

One of the trees grew in a shaded situation but the others were receiving plenty of light at the time of cutting. A study of the diametral growth, however, indicated a common period of slow growth dating backward from 20 years ago. All of the trees, even the one 181 years old, showed an improvement in rate of growth during the last 20 years.

The specific gravity determinations for this material show greater variations than did that from North Carolina. While the average values for the individual trees present some variations, there appears to be a uniform decrease accompanying the periods of slow diametral growth. The oldest tree produced wood of high specific gravity for 80 years, then wood of lower and lower specific gravity during another period of 80 years until 20 years ago, when a reversal took place. No reason for these changes can be positively assigned because sufficient history of the stand is not available.

The situation in the Mississippi River bottom represents the typical overflow delta formation, with canebrakes at intervals and poison ivy everywhere abundant. The soil is very rich and the surface level.

Normally only a few feet above the river, the area is covered with water for several months of winter and early spring. It has no levee protection and at the time of high water is said to be inundated to a depth of 16 feet. The forest is rather open and irregular, owing to lumbering at various intervals. The present stand consists of the native species of oak and hickory, hackberry, elm, red gum, and white, green, and pumpkin ash. The material taken represents white ash trees from 40 to 120 years of age. Two of them had narrow rings at the center, but all had been making very rapid growth during the greater part of their existence.

Although the average specific gravity values for this site did not differ much from those for the other sites studied, an exception to the general internal variation must be noted. In this situation the material from the base of the trees averaged lower in specific gravity than the material 16 feet above the ground. The reverse was true for all specimens from the other localities. The production of lighter material at the base of these trees may reasonably be attributed to excessive moisture conditions.

The wood comprised in the narrow rings at the center of the two trees mentioned was heavier than wider-ringed wood from the outside.

In Arkansas two sites located in the Ozark National Forest were chosen. The first situation is at the head of Sycamore Creek near the Oak Mountain ranger station, in the northwestern part of Pope County; the other is in Callan Hollow near Simpson, about 12 miles west of Oak Mountain. The streams draining these situations are tributary to the Illinois Bayou. The trees were secured from sites near the tops of the ridges at an elevation of about 1,800 feet; they could be found only on northerly or easterly slopes, owing probably to the fact that the southerly and westerly slopes have been frequently burned over.

At Sycamore Creek the forest type consists of mixed hardwoods including white and black oaks, hickories, elm, ash, and gum. The soil is a stony loam well supplied with moisture and with a moderate amount of humus present. The stand is fairly dense and the trees tall and straight, one of them reaching a height of 115 feet. Seven trees, ranging in age from 63 to 110 years, were secured.

The location in Callan Hollow, like that on Sycamore Creek, has a northeastern exposure. The character of the forest is somewhat different, with a rather open stand of oaks, black gum, hickory, white ash, and black locust, making up the merchantable stand and a dense

thicket of young oaks and hickories about 25 feet high for an understory. The site is above the steeper slopes of the ravine and not watered by any surface streams or springs.

The material collected from Sycamore Creek is of very uniform specific gravity, and presents further evidence that slow growth during the early life of white ash does not result in material of low quality. One tree, however, shows a depreciation in quality accompanying slower growth during the later periods of its life. The slow-growth wood at the centers of all trees studied from this location is exceptionally heavy, so that in comparison the wood of more normal growth on the outside is noticeably higher; but none of the specimens show material sufficiently low in quality to be objectionable.

The trees from Callan Hollow, with two exceptions, are about equivalent in value to those from Sycamore Creek, and have similar characteristics. The two trees excepted show evidence of unfavorable conditions. One was defective at the base, owing, probably, to injury by fire. Both were rather unfavorably situated with respect to soil moisture, as they stood at a higher elevation than the rest where the soil was less protected by undergrowth and had a steeper slope, allowing more rapid surface runoff. The other trees furnished material whose growth ranged from slow to rapid. The most remarkable fact is that the youngest, fastest growing tree and the oldest, slowest growing tree furnished wood having the highest average specific gravity values.

The material from northeastern Ohio was collected with the purpose of securing material from locations where a fairly accurate history of conditions affecting the stand during the life of the trees could be determined.

Three woodlots were found which seemed to answer requirements. Two of these are situated in Geauga County, near the village of Chardon, Ohio, about 30 miles east of Cleveland, the first being situated about three miles directly south of Chardon on the property of C. R. Spencer, and the other about six miles to the southeast on the property of J. M. Brown. The direct distance from one woodlot to the other is about five miles. According to the Bureau of Soils both are situated on the type of soil designated Volusia clay loam and described as a rather heavy soil not usually well drained and subject to baking and cracking when dry, with the underlying subsoil dense and compact so as to cause slow movement of moisture.

The Spencer lot is situated on a level area of high ground having

an elevation of 1,200 feet. The soil evidently possesses suitable qualities for a satisfactory forest growth, but farm lands adjoining are not highly productive. The forest consists of a second-growth of mixed hardwoods 60 years of age, of which white ash constitutes approximately 50 per cent. Other species occurring in considerable number are sugar maple and beech, while yellow poplar, black cherry, hickory, and basswood are also present to a less extent. The stand is fairly dense, averaging 170 to 200 trees per acre. The rate of diametral growth of the white ash trees has decreased considerably during the past 25 to 30 years, owing, apparently, to competition for growing space and a reduction of crown area with the exclusion of sunlight from the lower branches. In all cases examined the material of slow growth on the outside of the trees was of lower specific gravity than that of more rapid growth within.

The situation of the Brown woodlot is similar to that of the foregoing with respect to elevation and soil type. A small creek flows through it, making the topography a little more uneven and probably improving drainage conditions somewhat.

Owing to lumbering about 35 years ago the forest growth consists of an uneven-aged stand. It averages 150 trees per acre at the present time. The principal species present are sugar maple, white ash, beech, hickory, elm, and basswood. Sugar maple predominates, ranging in size from 4 to 24 inches, d. b. h., the older trees being survivors of logging. The other species mentioned belong to the younger age classes. The white ash trees selected ranged in age from 60 to 75 years. They had grown slowly at first but after the lumbering had made very rapid development and maintained dominant positions in the crown cover. The effect of lumbering was similar to that of a heavy thinning, resulting in a remarkable increase in the rate of growth of the white ash. There was no great difference in the specific gravity of the wood from the inside and the outside of these trees.

The third woodlot is situated near Medina, about 30 miles directly south of Cleveland. The general topography is rolling, with elevations reaching above the 1,200-foot level.

The upland soils are derived from glacial till, with Miami clay loam as the predominating type. In the higher situations this type is well drained. The woodlot from which material was obtained for study is located five miles in a southeasterly direction from Medina on the farm of F. A. Phillips. It is situated at an elevation of 1,150 feet near the top of a ridge dividing two tributaries of Rocky Creek.

TABLE I.

Comparison of average[1] specific gravity values for white ash from nine situations and five localities.

Shipment No.	Data as to site from which shipment was taken: Locality	Situation	Elevation	Soil type	No. of trees represented in shipment	Height in tree from which specimens were taken	Average specific gravity of all specimens in shipment, oven dry
			Feet			Feet	
930	Buncombe Co., N. C.	Dillingham Creek	3,500	Black loam	7	16	.687
		Biltmore Estate (plantation)	2,000	Alluvial sandy loam	5	8–16	.729[2]
931	Shelby Co., Tenn.	Wolf River	250	Silt loam	6	16	.633
932		Miss. River	30	Alluvial silty clay loam	6	16	.688
933	Pope Co., Ark.	Sycamore Creek	1,800	Stony loam	7	16	.666
		Callan Hollow	1,800	Stony loam	6	16	.668
964	Geauga Co., Ohio	Chardon-Spencer woodlot	1,200	Clay loam	5	14	.633
		Chardon-Brown woodlot	1,200	Clay loam	5	13	.645
965	Medina Co., Ohio	Medina	1,150	Clay loam	5	12-14	.625

[1]In order that comparisons may be made on a uniform basis, the values in the right-hand column are averages of material from a point in each tree ranging usually from 12 to 16 feet above the ground. This portion of the bole has been found to be the most representative of all the material in a tree.

[2]The unusually high value for the material from the Biltmore plantation is attributed to the fact that all the trees were young (20 years old); material in the center of several older trees elsewhere was found to have equally high values.

Steep slopes extend in northerly and easterly directions to the creek bottoms, which are 150 feet lower and the drainage is consequently very good. The soil on this site is not so heavy as on the woodlots in Geauga County. This woodlot comprises a nearly even-aged stand of hardwoods about 50 years of age, consisting of sugar maple, white ash, black cherry, and a few other species. The stand, which is fully stocked to an average of 250 trees per acre, has not been thinned except by the removal of a number of black cherry trees two years ago. The growth of the white ash trees has slowed down in a marked degree during the last 15 years and the process has been accompanied by the production of wood of lower specific gravity, as in the case of the Spencer woodlot.

COMPARISON OF RESULTS

A comparison of the average specific gravity values of white ash from all the sites described in the foregoing pages (see Table I) reveals no great differences in the specific gravity of the wood on account of the geographical location of the site. Wider variations are found by comparing the average specific gravity values for individual trees from the same site, while in some instances still greater variations are found to exist for different parts of the boles of individual trees.

This fact must, of itself, explode the theory that within its natural range geographic location determines the technical properties of white ash wood. The results of these determinations also indicate that the wood quality may not be the direct result either of the soil type or of the amount of rainfall (in excess of that required for normal growth of the tree), since trees growing on the same kind of soil and only a short distance from each other manifest different behavior over the same periods of time.

It therefore appears that the specific gravity of the wood of an individual tree must depend more upon the factors immediately influencing the growth of that tree, and that these factors acting separately, or in combination, may from time to time create conditions which change materially the character of the wood formed.

The three Ohio woodlots afford the best data upon which to explain variations in specific gravity, since a more complete history of conditions existing throughout the life of the stand was obtainable there than in the other localities. The greatest variations found existed between individual trees and in the wood from different parts

of the trees. For the trees from both the Spencer and Phillips woodlots an analysis of the specific gravity values with respect to the position of the specimen in the bole of the tree showed a consistent variation between the wood from the inside of the bole and that from the outside, there being a decided decrease in the specific gravity values for the latter (see Table II). The lighter wood was formed during periods in which the diametral growth of the trees was greatly retarded and corresponds to the intervals during which the stands were most congested. The trees from the Brown woodlot, on the other hand, showed no such abrupt decrease in specific gravity and, furthermore, the rate of diametral growth, instead of decreasing, had more than doubled immediately following a thinning of the stand which occurred about 30 years ago. In this stand, therefore, the white ash

TABLE II.

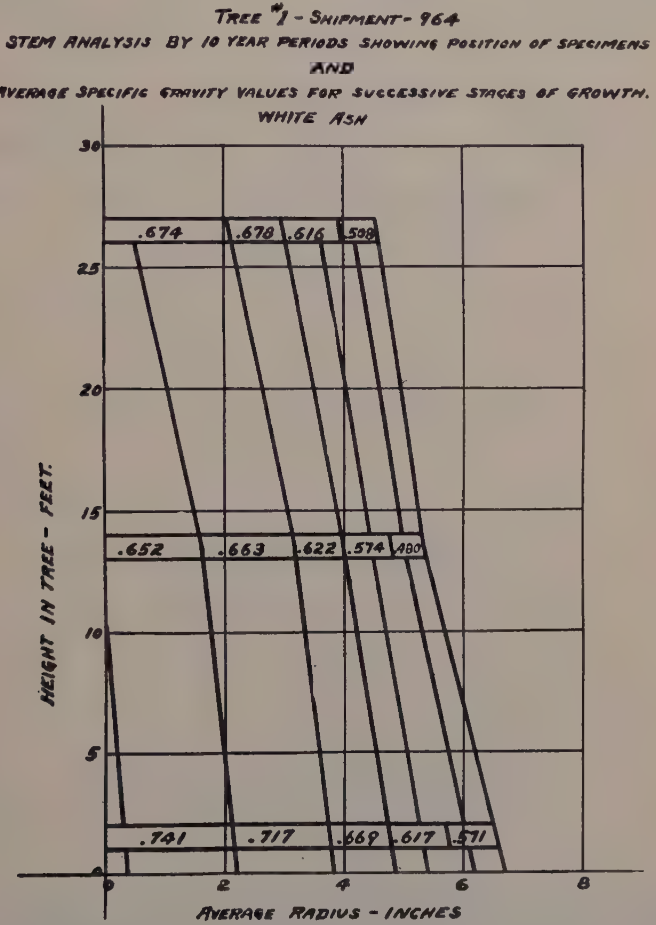
Comparison of specific gravity values of white ash for different periods in the life of trees from thinned and from unthinned stands.

Shipment No.	Site	Tree No.	Average specific gravity values under different conditions of density in the stand		Change in specific gravity—average for tree	Change in specific gravity—average for site
			Before crowding, first 30-35 years	After crowding, last 30 years		
						Per cent
964	Spencer woodlot	1	.677	.561	—.116	
		2	.694	.659	—.035	
		3	.710	.646	—.064	
		4	.682	.657	—.025	
		5	.704	.652	—.052	— 8.4
			Before thinning, first 30-40 years	After thinning, last 30 years		
964	Brown woodlot	6	.636	.638	+.002	
		7	.698	.660	—.038[2]	
		8	.633	.632	—.001	
		9	.664	.668	+.004	
		10	.676	.673	—.003	— 0.11
			Before crowding, first 30-35 years	After crowding, last 15 years		
965	Phillips woodlot	1	.628	.590	—.038	
		2	.677	.562	—.115	
		3	.701	.590	—.111	
		4	.688	.623	—.065	
		5	.676	.629	—.047	—11.1

[2]Tree No. 7 has been growing in a dense situation and shows a decrease in the rate of diametral growth during the last 15 years.

trees not only maintained the production of wood of uniform specific gravity, but also doubled the volume of wood produced.

Diagrammatic representations of changes in rate of diametral



Stem analysis diagram by 10-year periods for white ash tree No. 1, from Spencer woodlot, showing retardation in rate of diametral growth and accompanying changes in specific gravity for cross sections at heights of 1½, 13½, and 26½ feet in the tree.

Fig. 1.

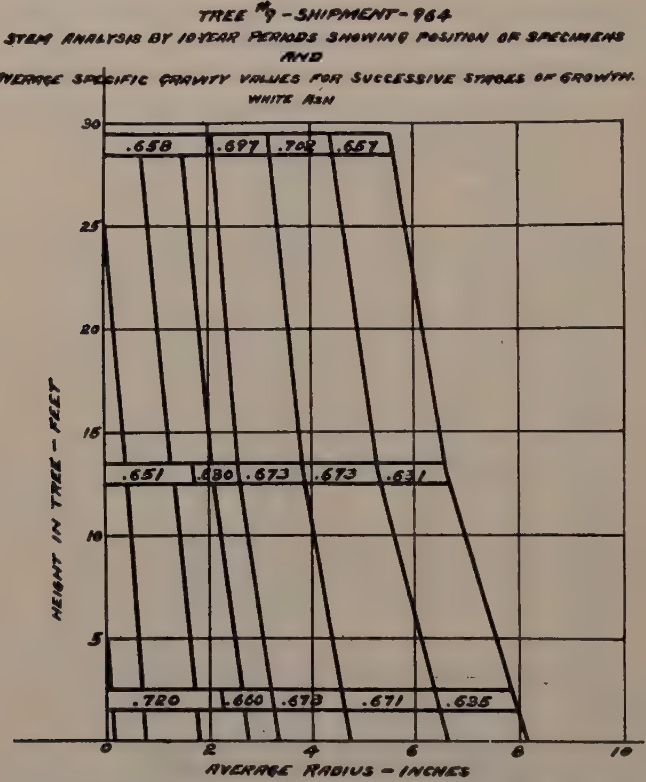
growth with the resulting specific gravity values are shown in the accompanying illustrations (Figs. 1 to 4).

SUMMARY

A comparison of specific gravity values of white ash from the Appalachian Mountains, the Mississippi Valley, the Ozark Mountains,

and Ohio, indicates that the influence of locality upon the properties of the wood formed is not as great as the influence of the other factors which directly affect the growth of the individual trees.

Under normal conditions of growth the wood having the highest specific gravity is found at he base of a tree, but white ash trees which



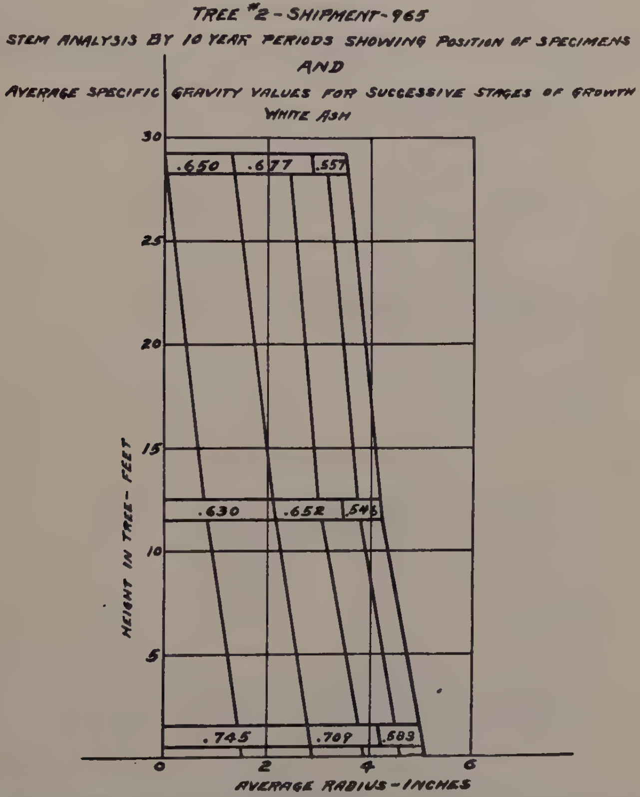
Stem analysis diagram by 10-year periods for white ash tree No. 9, from Brown woodlot showing greatly accelerated diametral growth after thinning and the accompanying specific gravity values for cross sections at heights of 1, 13, and 30 feet in the tree.

Fig. 2.

had grown under excessive water conditions in the Mississippi bottom contained wood of lower specific gravity near the ground than at a height of 16 feet or more in the bole. Acceleration of growth in this situation impaired rather than improved the quality of the wood. The average specific gravity values for the wood specimens from a point 16 feet above the ground in the trees grown in this wet location were

just as high as the average values for specimens from a correpsonding height in the trees from the other sites represented.

The width of annual rings or growth layers is not an index of wood quality of white ash unless considered with respect to the life history of the tree. This conclusion is fully warranted by the following deductions from the specific gravity determinations:

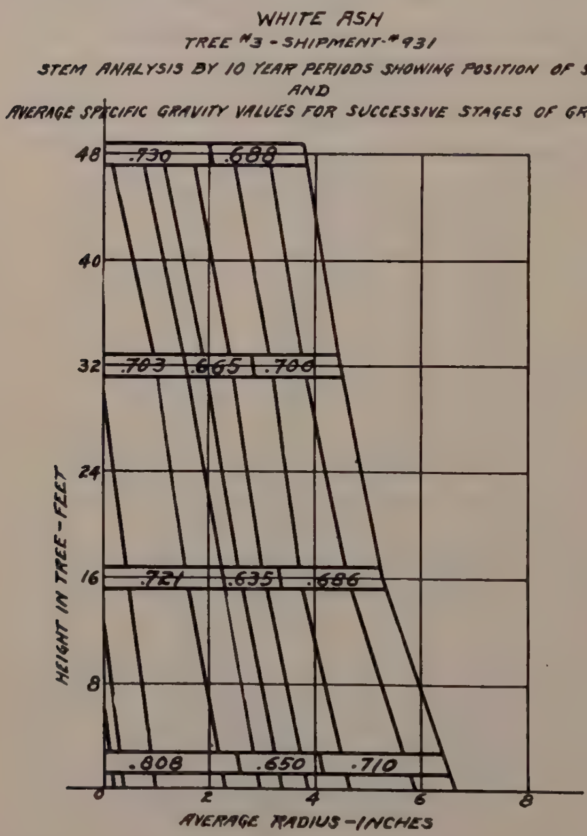


Stem analysis diagram by 10-year periods for white ash tree No. 2, from Phillips woodlot, showing retardation in rate of diametral growth and accompanying changes in specific gravity for cross sections at heights of 1, 12, and 29 feet in the tree.

Fig. 3.

1. The rate of growth of white ash during the early life of a tree does not seem to influence the specific gravity, since wood of high specific gravity was formed whether growth was rapid or slow.
2. Trees which maintained a nearly uniform rate of diametral growth did not show any wide differences in the specific gravity of the wood produced at different periods in their lives.

3. A retardation of normal growth, as exhibited by a sudden change in the width of growth rings, resulted in the formation of wood of lower specific gravity.
4. Restoration of normal growth resulted in the formation of wood of higher specific gravity.



Stem analysis diagram by 10-year periods for white ash tree No. 3, from Wolf River, Tenn., showing period of retarded diametral growth and subsequent recovery and corresponding changes in specific gravity values for cross sections at heights of 1, 16, 32, and 48 feet in the tree.

Fig. 4.

In two woodlots which have had little or no thinning, the white ash trees show a decrease in rate of diametral growth due to crowding. This decrease is accompanied by a considerable falling off in the specific gravity of the wood.

White ash trees from another woodlot thinned as the result of

logging 30 years ago, show a remarkable increase in rate of diametral growth since thinning and during the same time have produced wood having no abnormal or abrupt changes in specific gravity values. White ash wood from the thinned stand shows only about half as much variation in specific gravity as that from the unthinned stands.

The volume of wood produced during the last 30 years by five trees from the thinned stand is nearly double the amount produced during the same time by five trees from an unthinned stand of approximately equal age and similar site conditions, although the total volume of the latter was the greater at the outset.

The results of this investigation show that when other conditions are favorable, thinnings in a crowded stand of white ash will not only assist in a continuation of the normal growth rate, but will tend to prevent a falling off in the specific gravity of the wood formed.

It appears from this study that white ash stands will produce wood having the most uniform properties and the highest quality with respect both to mechanical properties and freedom from defects, when the trees are grown in such a close formation while young that subsequent thinnings will maintain or increase their rate of diametral growth.

A SCHEME FOR SYSTEMATIC IDENTIFICATION OF WOODS WITH THE AID OF A HAND LENS

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I. INTRODUCTION

From the comparatively great number of efforts made to get a really convenient key for the identification of wood according to structural characteristics[1] it can be concluded that there is a need for it, and that an allround useful key is not yet obtained.

This last fact is largely due to the lack of a systematic scheme in the descriptions of qualities and structure of the woods and to a not always successful choice of characteristics for determination. In many cases this is due to insufficient knowledge of the anatomy of wood and specially of the relative merit of these characteristics. Indeed, with an increasing number of woods these difficulties become so large, that Stone[2], for example, says: "I have not attempted a key to the species, as I consider that the knowledge of the structure of wood is not sufficiently advanced to permit of the construction of one, which shall be in harmony with the natural system of classification. I have a key which often enables me to refer an unknown wood to its Genus, but the keys that have been published so far, are so unsatisfactory, that I have hesitated to add another empirical guide to those already existing."

In the last 20 years, however, there is a definite progress. We notice this along two different lines, i. e. (1) for detailed scientific use and (2) for practical uses only. In the first case distinctions are based on the structural differences in wood as they are to be seen with a compound microscope. In the second case, use is made only of characteristics, visible with the naked eye and by the help of a good hand lens.

The microscopic method was the first to come to a high degree of perfection and a frequent application. Recently the work of Professor

[1]The following only are mentioned: Hartig, Die Unterscheidungsmerkmale der wichtigen, in Deutschland wachsenden Hölzer, 1879. T. F. Hanausek, Lehrbuch der Technische Microscopie, 1901. H. Marshall Ward, Timber and some of its diseases, 1909. S. J. Record, Identification of Economic Woods of United States, 1912. A. Koehler, Guidebook for the Identification of Woods Used for Ties and Timbers. U. S. Forest Service, 1917. Ir. M. E. H. Tjaden, Microscopisch onderzoek van hout, 1919.

[2]Herbert Stone, The Timbers of Commerce and their Identification. London, 1905.

Dr. J. W. Moll,[3] for example, has shown the application of such a method. He has applied the Linnean method for phytography to the description of wood structure. The important work of Moll and Janssonius on the woods of Java, in which this method reaches its highest perfection, has inspired already many followers.

In many countries there is an increasing use of exotic and so far not common woods. This has increased largely the demand for methods of identification which could be applied without elaborate equipment. A method is wanted that is not for laboratory use only, but that can be learned and applied by those of an average education, whose work has to do with the handling of wood, as in the case of architects, contractors, lumber dealers, etc.

The best way, the observation of the transverse surface with a hand lens was already a common practice, but the results were not always sufficiently dependable; the keys sometimes did not hold for more than a limited number of woods, and did not always exclude others.[4] One of us, nevertheless, formed from personal experience the conviction that with the following methods better results could be produced. This conviction was based on the fact that with a good hand lens in the hardwoods[5] most of the characteristics and the more important ones, of the arrangement of tissues (topography) can be observed. The same holds for the cell characteristics so important from the systematic point of view. It has already been explained[6] that if one studies normal wood formed in the tree at a not too early age, the study of topography gives the best and most constant characteristics. In that work it has been shown that several characteristics commonly used in the microscopic methods, as for example width of rays in number of cells, and presence of crystals in parenchyma cells, may vary widely according to soil and condition of growth. Such inconsistencies may lead to serious mistakes. The topographic characteristics have the additional advantage of being perfectly visible with a hand lens, often they show up even better than when thin sections are viewed at higher microscopic magnification.

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[3]J. W. Moll, Handbuch der Botanische Micrographie, 1907.

[4]See criticism by Dr. L. G. den Berger in his paper: Key of the most important commercial woods of Malakka. Tectona, 1922. XV, p. 305.

[5]The possibility of application of this method to softwoods has not yet been thoroughly tried out; preliminary work indicates, however, that very likely there is such a possibility.

[6]J. Ph. Pfeiffer: Value of Scientific Research for the determination of Technical Properties of Lumber (Thesis 1917 in the Dutch language). J. H. de Bussy, Amsterdam.

The hand lens allows an easier examination of large surfaces and greater speed, thus permitting the study of a larger number of samples. It, therefore, makes it easier to determine the consistency or inconsistency of characteristics for species, genera, or families. This is an important advantage of the hand lens method.

That is why the statement has been made[7] that at the present stage of science for a practical identification of hardwoods the hand lens gives about as useful results as the microscope, besides the technical advantages of the former, which make it the better one for daily use.

When both methods are combined, as has been attempted[8] the disadvantages of both will remain. The results do not always make up for the confusion which results from following two lines of thought at the same time.

Professor Dr. H. Beekman and Dr. L. G. den Berger[9] have systematically developed the hand lens method of describing the structure of wood, as Professor Moll has done the microscopic method. Moreover, they are the first to have proved that with the modern hand lenses of 10 and 20X magnification, the nature of the perforation of vessels or tracheae and the form and character of the rays can be determined without difficulty.

This method specially is considered in what follows and its usefulness was tried out for a number of hardwoods native to western Europe. It is noted that for the identification of woods of the Dutch East Indies, for which it was originally developed, this method has already given important results. With some additions and improvements it is anticipated that it will be very useful for researches on the value of wood structure in connection with the systematic bontanical relationships of trees because of the quickness and ease of applying the method. In this paper is included a key for identifying certain common European woods by the methods developed. This was originally published[10] in Dutch. As well as a key for identification detailed descriptions of the species discussed, are given here. These descriptions supplement the key and

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[7]J. Ph. Pfeiffer: Plan of work for the committee of advice and research of woods from Dutch Guiana. Pub. in De Ingenieur, 1923.

[8]M. E. H. Tjaden—Microscopic research of wood. Pub. by L. J. Veen, Amsterdam, 1919.

[9]H. Beekman—78 Woods from the Preanger. Report No. 5 of the Forest Research Institute, Buitenzorg, Java, 1920 and Dr. L. G. den Berger—Introduction to the identification of wood in practice. Report No. 7 of the Forest Research Institute, Buitenzorg, Java, 1922.

[10]"De Ingenieur," 1923. Nos. 47 and 48. Weekly publication of the Royal Institute of Dutch Engineers. The Hague, Holland.

aid greatly in the identification of the genera considered.

For the many woods studied, by Pfeiffer specially those of East India and Dutch Guiana, a more extensive key has also been developed. Before publication could be considered, however, it was desirable to know whether the method of identification descriptions would also work for western European woods. Since they are in so many ways closely related to the North American species, this is presented here in English.[11] It should be kept in mind, however, that the writers consider the attached key as merely a part of a larger and more comprehensive identification scheme which it is hoped can follow before very long.

EQUIPMENT AND STRUCTURAL CHARACTERISTICS

Before we can proceed to describe the European woods here presented with the aid of the methods which are here discussed, it is necessary to give attention to the instruments used and the structural features described as criteria for identification. The before mentioned paper of den Berger and Beekman[12] also gives a helpful presentation of the application of these methods.

The equipment is very simple. A good hand lens with 10X linear magnification; a sharp knife or chisel; a piece of paper ruled in square millimeters, in which holes are cut of 1 and 4 square millimeters, for counting numbers and making measurements[13] are all that is required.

It is desirable to plane and surface the specimens used accurately in the transverse, radial, and tangential directions. Dimensions of 10 cm. in radial direction, 7½ by 7½ cm. in tangential and axial directions are sufficient. It is advisable to examine the planes of importance all over, so that no details can escape the attention. The transverse plane is smoothed at one or more spots with the knife, a sharp one, and the smooth cuts then examined with the hand lens. Sometimes it is of advantage to moisten the cuts as that may bring out some details better, as for example, parenchyma. *A radial split is always necessary,* and makes it possible specially to examine: The nature of the perforations

[11]The authors express their indebtedness to Dr. Eloise Gerry, Madison, Wisconsin, U. S. A., for the many helpful suggestions given during the preparation of this publication in English.

[12]See footnote page 5. This can be obtained from Director of Research Station at Buitenzorg, Java (in Dutch) price 75 cents. A collection of samples may also be obtained for 75 cents.

[13]One can use better still a good microscopic slide, in which two sets of divisions, one in square millimeters, the other parallel lines, 1/5 millimeter apart are ruled or etched.

or endings of the pores or vessels, the number of vessel segments and details about the structure of rays. This last characteristic has to be examined also on the tangential plane. It is here, too, that storied structures can be discovered best.

The characteristic features selected for criteria of identification include: specific gravity, grain, cleavability, luster, color, smell, taste, water extracts, and how the wood burns. Further characteristics used in relation to the structure of the wood are: growth-rings, pores, fibers, rays, parenchyma, resin and gum ducts, and latex tubes, pith flecks, and storied structures.

Growth rings, often visible with the naked eye on the transverse plane, offer good general information, but hardly ever main characteristics. The periodicity observed in the grouping of pores, their size and number; presence, character and amount of parenchyma and density of fiber are described. Regarding the *pores,* the grouping, distribution, size, number, perforations, segments and contents are noted. *Grouping* means the position of pores with relation to each other; single or in groups, how many make up the groups and in what direction they extend. The *distribution* includes how pores or groups of pores are placed in the wood, whether they are locally absent; if so, where, and whether there is anything regular about number and direction.

With the help of a ruled glass slide the *size* of the pores may be measured and their *number* per unit area counted. To make it easier to compare these data, Berger and Beekman use certain groups for which terms are given. These are carefully selected and limited on both sides by numbers.

A very important characteristic is found in the *perforations* or pore endings of the vessel segments. These can be either simple, scalariform or mesh-like. The last can be best observed on the transverse plane. The simple and scalariform perforations are best seen on the radial split surface. Here the number of segments per mm. in axial direction are counted too. The contents of pores include tyloses and other matter.

The *fibers* do not form an important characterstic, their relative density is described, and if conspicuous the part of surface area they cover.

Parenchyma tissue is divided in ray and wood parenchyma. In both cases a classification slightly different from that of den Berger and Beekman, which the writers think has some systematical advantages, is followed.

Under *ray-parenchyma* there is again a division into three groups, according to the presence of: *a.* One kind of rays; *b.* two kinds of rays with the main difference in obviously differing *sizes; c.* two kinds of rays with the main difference in contrasting ray *cell structure.* For rays size, number, height and structure, and when two kinds are present, the relation between numbers present of both are used. In regard to *wood-parenchyma,* visible mainly on the transverse plane, the discrimination is made between: (1) *paratracheal,* (2) *definitely arranged,* and (3) *scattered parenchyma.*[14] *Paratracheal* means: parenchyma bordering the pores and present as simple rings, parts of rings, or rings variously extended, or rings with typical forms. The kind, presence around all or part of the pores, or round pores in special parts of growth ring only is described.

Definitely arranged parenchyma means: all parenchyma that is arranged regularly or periodically, for instance as long and continued rows, as rows in which it is scattered, or as longer or shorter continued or partly discontinued rows.

Scattered parenchyma means: all metatracheal or generally scattered parenchyma that is not regularly or periodically arranged. An estimation of frequency is mentioned and if there is any linking up with paratracheal parenchyma. Different possible intermediate stages are described.

In some woods special formations are commented on: pith flecks, resin and gum ducts, and latex tubes, storied structures, bark tissue formations and phloem. These are important characteristics for those families in which they appear and their presence and their kind are considered.

The following descriptions are based on samples from the collections of the Department of Technical Botany and the Laboratory of "Kennis van Bouwstoffen" (knowledge of building material) at the Technical University in Delft, Holland. Thanks are due to Professors Dr. G. van Iterson and Chr. Visser, in charge, respectively, of the above mentioned institutes for the material studied. In those cases where the

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[14]In accordance with den Berger and Beekman's definition generally scattered parenchyma is considered to be separate parenchyma cells or very small groups of cells unrelatedly distributed through the fiber tissue.

As soon as there is a definite linkage formation in a tangential direction, for example, or if little bands or lines are formed which at least reach from one ray to another, it is called metatracheal parenchyma.

Parenchyma on the division between summer and springwood is called terminal.

samples obtained were not sufficiently representative, other material of definitely known origin (for example in the case of apple and pear) was bought.

Photographs magnified 10X were used to illustrate the original article. These were originally 9x12 cm. in size. Most of the surfaces shown were prepared with the microtome. The illumination for photographing was obtained by the use of a Silverman Illuminator.

The exact relations in meaning here used between the degrees of modification of size, number, etc., are expressed below.

PORES

Size (measured radially): Very, very small, less than 20 mu; very small 20-50 mu; small 50-100 mu; comparatively small 100-200 mu; comparatively large 200-300 mu; large 300-400 mu; very large, more than 400 mu.

Number per square mm.: Very few, less than 2; few 2-5; comparatively few 5-10; comparatively numerous 10-20; numerous 20-40; very numerous, more than 40.

FIBERS

Dense when no lumina can be seen with the hand lens on the cross section. Comparatively dense when it is just possible to observe the lumina. Not very dense, when the lumina are observed as comparatively wide in relation to the fiber walls.

WOOD AND RAY PARENCHYMA

Lines of Parenchyma.

Length (radially measured): Very short 25 mu; short 25-50 mu; comparatively short 50-100 mu; comparatively long 100-200 mu; long 200-300 mu; very long 300 mu.

Number (measured radially per mm.): Very few, less than 1; few 1; comparatively few 2; comparatively numerous 3; numerous 4-5; very numerous 6 and more.

RAYS

Size: Very narrow, less than 15 mu; narrow 15-30 mu; comparatively narrow 30-50 mu; comparatively broad 50-100 mu; broad 100-200 mu; very broad 200-400 mu; exceptionally broad more than 400 mu.

Number (per mm. measured tangentially): Very few up to 3; few 4-5; comparatively few 6-7; comparatively numerous 8-10; numerous 11-15; very numerous more than 15.

Height: Extremely low, less than ½ mm.; very low ½-1 mm.; low 1-2 mm.; comparatively low 2-5 mm.; comparatively high 5-10 mm.; high 1-2 cm.; very high 2-5 cm.; exceptionally high more than 5 cm.

Specific gravity: Exceptionally light 0.3 and lower; very light 0.3-0.4; light 0.4-0.5; comparatively light 0.5-0.6; comparatively heavy 0.6-0.75; heavy 0.75-0.9; very heavy 0.9-1.05; exceptionally heavy more than 1.05.

POPLAR (POPULUS TREMULA L.)

Specific gravity: Light (0.4-0.5); *grain:* straight; *cleavability:* splits very easily; *luster:* poor; *color:* light yellow to white; *smell:* not characteristic; *taste:* the same; *extract:* light brown; *burns:* rather difficulty, very small amount of light gray ash.

Wood Structure

GROWTH-RINGS

Definite; all pores are small, but in the late autumnwood smaller on an average than elsewhere. The boundary of the annual ring is definite, because of the denser fiber structure in the late summerwood.

PORES

Grouping: Most of the pores in groups of 2, 3 or 4 in radial direction, single pores also present.

Distribution: Even, a little less frequent in the latest part of the summerwood.

Surrounding elements: Touch rays often on one side, seldom on both sides, since the average distance of the rays is greater than the tangential diameter of the pores; surrounded by fibers and now and then by scattered parenchyma.

Size: Small (40-60 mu).

Number: Very numerous (40-80 per square mm.).

Perforations: Simple.

Vessel segments: 1-3, average 2 per mm.

Contents: None.

FIBERS

Not very dense, cover ½-⅓ of the cross section.

PARENCHYMA

Paratracheal and *definitely arranged:* Not apparent.

Scattered: Difficult to observe, but found as somewhat lighter flecks and spots.

RAYS

One kind.
Size: Very narrow.
Number: Numerous (12 per mm.)
Height: Extremely low.
Structure: Entirely made up of flat cells.

SPECIAL FORMATIONS

None.

WILLOW (SALIX ALBA L.)

Specific gravity: Light (0.45-0.55); *grain:* straight; *clcavability:* splits very easily; *lustre:* fair; *color:* rose yellowish, white—dingy white; *smell:* not characteristic; *taste:* the same; *extract:* colorless; *burns:* rather well, quietly, has a white ash.

Wood Structure

GROWTH-RINGS

Definite; the diameter of the pores decreases in the summerwood towards the end of the annual ring. The pores are much smaller there than in the rest of the growth-ring. The boundary of the ring is sharp and formed by a narrow band of terminal parenchyma, and the dense fibers of the late summerwood.

PORES

Grouping: Most pores single, some in groups of 2-4.
Distribution: Rather evenly distributed.
Surrounding elements: Generally on one side, not infrequently on both sides touching the rays, as the distance between those is, on an average, just a little larger than the tangential diameter of the pores.
Size: Very small (30-50 mu).
Number: Very numerous (60-90 per square mm.).
Perforations: Simple.
Vessel segments: 2-4, average 3 per mm.
Contents: None.

FIBERS

Comparatively dense.

PARENCHYMA

Paratracheal: Unobservable.

Definitely arranged: As thin terminal bands on all the boundaries of annual rings.

Scattered: Not apparent.

RAYS

One kind.

Size: Very small.

Height: Extremely low.

Number: Numerous (10-14 per mm.).

Structure: Built up of flat cells, with one to three rows of short high cells on the outside.

SPECIAL FORMATIONS

Pith flecks are rather frequent, but not always present. No other special formations.

WALNUT (JUGLANS REGIA L.)

Specific gravity: Comparatively light—comparatively heavy (0.55-0.7); *grain:* straight; *cleavability:* splits rather easily; *luster:* poor to fair; *color:* grayish brown to violettish brown; *smell:* not characteristic; *taste:* the same; *extract:* dark yellowish; *burns:* well, quietly, gives a white ash.

Wood Structure

GROWTH-RINGS

Rather definite, the diameter of the pores gradually but noticeably decreases from springwood to summerwood. The boundary of the annual ring is sharp because of the presence of terminal parenchyma and marked because the biggest pores of the springwood are arranged in a tangential row.

PORES

Grouping: Generally single, the rest in groups of 2-4.

Distribution: Fairly evenly distributed, except the big pores near the boundary, which form a more or less definite tangential row.

Surrounding elements: The big pores touch the rays generally on both sides, the smaller ones on one side since the average distance between rays lies between the tangential diameters of the big and the small pores. A number of pores are partly surrounded by parenchyma, the

rest with fibers.

Size: Gradually decreasing from comparatively large (250 mu) to small (50 mu), average comparatively small.

Number: Comparatively few (6-10 per square mm.).

Perforations: Simple.

Vessel segments: 2-4 per mm.

Contents: Tyloses.

FIBERS

Dense.

PARENCHYMA

Paratracheal: Difficult to observe, appears as an incomplete ring around a few of the pores.

Definitely arranged: In narrow to very narrow, metatracheal, short or very short bands, frequently interrupted and now and then gradually changing in scattered parenchyma; these bands are numerous to very numerous and increase somewhat towards the end of the year's growth.

RAYS

One kind.

Size: Comparatively narrow.

Number: Comparatively numerous (8-10 per mm.)

Height: Extremely low.

Structure: Made up entirely from flat cells, along the outside of some a little row of short, high or of vertical cells.

SPECIAL FORMATIONS

None.

BLUE BEECH (CARPINUS BETULUS L.)

Specific gravity: Comparatively heavy to heavy (0.7-0.8); *grain:* almost straight; *cleavability:* splits difficultly; *luster:* poor; *color:* grayish white; *smell:* weakly acid, not very characteristic; *taste:* not characteristic; *extract:* light yellow; *burns:* rather well, quietly, a very small amount of gray ash.

Wood Structure

GROWTH-RINGS

Comparatively definite, metatracheal parenchyma, increasing from springwood to summerwood and is much less frequent or even absent in the earliest springwood. The boundary of the annual ring is sharp

because of a band of very dense fibers in the late summerwood, in which are conspicuous yellow flecks which look like parenchyma.

PORES

Grouping: Most of the pores in groups of 2 to 6 or 7, with definite radial direction, single pores also present.

Distribution: Evenly distributed.

Surrounding elements: Generally on one radial side, but not infrequetly on both sides touching the rays, as the average distance between the rays is only slightly bigger than the tangential diameter of the pores. On the tangential sides now and then surrounded by parenchyma, for the rest by fibers.

Size: Very, very small, to very small, pores in the summerwood somewhat smaller than elsewhere.

Number: Numerous (25-40 per square mm.).

Perforations: Simple.

Vessel segments: 4-6 per mm.

Contents: None.

FIBERS

Dense, density increasing from springwood to summerwood; in the late summerwood and at the boundary line a very dense fiber tissue of a special color.

PARENCHYMA

Paratracheal: Not apparent.

Definitely arranged: In very short, very numerous thin wavelike bands, which sometimes are linked up together. They increase from springwood to summerwood and form gradual changes to scattered parenchyma which occurs locally or in extremely short bands.

RAYS

One kind; now and then in indefinite bundles (aggregate), in which the distance between them is much smaller than in the rest of the wood and where seldom, or never, pores are placed between the aggregating rays.

Size: Comparatively small to small.

Number: Numerous to very numerous (12-17 per mm.).

Height: Extremely low.

Structure: Generally made up entirely of flat cells, a few with one to many short, high, sometimes even vertical cells.

SPECIAL FORMATIONS

None.

HAZEL (CORYLUS AVELLANA L.)

Specific gravity: Comparatively light—comparatively heavy (0.55-0.7); *grain:* straight; *cleavability:* splits easily; *luster:* fair; *color:* rose-white to yellow white; *smell:* not characteristic; *taste:* the same; *extract:* colorless; *burns:* well, quietly; has a dark gray, almost black ash.

Wood Structure

GROWTH-RINGS

Definite; number as well as diameter of the pores decreases from spring to summerwood. The boundary of the annual ring is rather sharp because of the change of the summerwood which has only few pores to the springwood which is rich in pores.

PORES

Grouping: Generally in radial groups of two to many, the rest single.

Distribution: Evenly distributed, except for the decreasing number from springwood to summerwood.

Surrounding elements: Often on both sides, almost always on one radial side touching the rays, as the average distance between the rays is the same or somewhat smaller than the tangential diameter of the pores. Fibers and sometimes parenchyma form the rest of the surrounding tissue.

Size: Very, very small to very small. Decreasing in size from springwood to summerwood.

Number: Numerous to very numerous (30-60 per square mm.).

Perforations: Scalariform.

Vessel segments: Not visible with hand lens.

Contents: None.

FIBERS

Dense, increasing in density from springwood to summerwood.

PARENCHYMA

Paratracheal: Not apparent.

Definitely arranged: As very short, often interrupted wavelike and very numerous metatracheal bands. In the springwood it changes into scattered bands and scattered cells.

RAYS

One kind, partly grouped in bundles (compound rays), in which they are close together, with parenchyma and fibers, but no pores in between.

Size: Small, the "compound rays" very wide.

Number: Numerous to very numerous (13-18 per mm.) in the "compound rays" very numerous (22-28 per mm.).

Height: Extremely low.

SPECIAL FORMATIONS

None.

BIRCH (BETULA VERRUCOSA EHRH.)

Specific gravity: Comparatively light—comparatively heavy (0.55-0.75); *grain:* straight; *cleavability:* splits easily; *luster:* fair; *color:* yellow white to yellow gray; *smell:* not characteristic; *taste:* the same; *extract:* colorless; *burns:* well, quickly; has a very small amount of gray ash.

Wood Structure

GROWTH-RINGS

Comparatively definite, generally regular. The pores in the late summerwood somewhat smaller than elsewhere. The boundary between summerwood and springwood is fairly sharp, because of a very thin band of very dense fiber material in the late summerwood.

PORES

Grouping: Generally in groups of 2-4 radially arranged, in the late summerwood a few cases of groups of more than four pores noted. Other pores single.

Distribution: Fairly equally distributed, single pores more frequent in the springwood than in the summerwood.

Surrounding elements: Touch the rays generally on one side, sometimes on both radial sides or not at all, as the average distance between the rays is 1½ times the tangential diameter of the pores. Fibers form the rest of the surrounding tissue.

Size: Small to very small (75-25 mm.), the pores in the summerwood are smaller than in the other part of the year's growth The size decreases towards the end of the summerwood.

Number: Numerous (20-40 per square mm.)

Perforations: Scalariform.

Vessel segments: 2-3 per mm.

Contents: None.

FIBERS

Dense to comparatively dense.

PARENCHYMA

Paratracheal and *definitely arranged* not apparent.

Scattered: Purely scattered parenchyma, not frequent and difficult to observe.

RAYS

One kind.

Size: Narrow.

Number: Comparatively numerous (8-10 per mm.).

Height: Extremely low.

Structure: Built up of flat cells with one or two rows of short, high cells on the outside.

SPECIAL FORMATIONS

Pith flecks are very frequent and hardly ever absent. No other special formation.

ALDER (ALNUS GLUTINOSA GOERTZ)

Specific gravity: Light to comparatively light (0.45-0.6); *grain:* straight; *cleavability:* splits easily; *luster:* poor to fair; *color:* rose to yellowish white; *smell:* not characteristic; *taste:* the same; *extract:* colorless; *burns:* rather well, gives a dark gray ash.

Wood Structure

GROWTH-RINGS

Comparatively definite, the pores increase in size and number from the springwood to the summerwood. The boundary of the growth-ring is sharp due to the presence of a small band dense fibers. The earliest pores in the springwood form a more or less definite tangential row.

PORES

Grouping: Most pores single, the rest in groups of 2-4, sometimes of more than 4.

Distribution: Rather equally distributed, except for the more or less definite tangential row in the springwood and a smaller number of pores in the late summerwood.

Surrounding elements: Touch rays generally at one or both radial sides, elsewhere fibers.

Size: Generally small (50-75 mu), in the late summerwood to very small (50-25 mu).

Number: Very numerous (40-80 per square mm.).

Perforations: Scalariform; as they are located in planes with different inclinations they look sometimes like simple perforations.

Vessel segments: 4-8 per mm.

Contents: None.

FIBERS

Dense, more so in the late summerwood.

PARENCHYMA

Paratracheal and *definitely arranged* not apparent.

Scattered: Very difficult to observe as purely scattered parenchyma, in some places changes to extremely short metatracheal bands.

RAYS

One kind, exceptionally bundles appear (compound), in which the distance between the rays is smaller than in the rest of the wood.

Size: Comparatively narrow.

Number: Numerous to very numerous (12-18 per mm.).

Height: Extremely low.

Structure: Made up of flat cells only.

SPECIAL FORMATIONS

Pith flecks occur not infrequently as scattered, reddish-yellow flecks. No other special formations.

BEECH (FAGUS SYLVATICA L.)

Specific gravity: Comparatively heavy—heavy (0.6-0.85); *grain:* straight; *cleavability:* splits with moderate difficulty; *luster:* fair; *color:* brownish gray to brown; *smell:* not characteristic; *taste:* the same; *extract:* dark brown; *burns:* easily; ash: light gray.

Wood Structure

GROWTH-RINGS

Definite; pores decrease considerably in size and number in the summerwood towards the end of the annual ring. The boundary of the annual ring is rather definite because of sudden change from the late summerwood with few pores and dense fibers to the springwood which is rich in pores and has less dense fibers.

PORES

Grouping: Most are single, quite a few in groups of two or three.

Distribution: Rather evenly distributed, in the autumnwood not so numerous.

Surrounding elements: Pores often surrounded by fibers, as the average distance of rays is two or three times the average tangential diameter of the pores they hardly ever touch more than one ray; sometimes parenchyma.

Size: Small (50-100 mu); in the late autumnwood very small to very, very small (50-15 mu).

Number: Very numerous (100 per square mm.).

Perforations: Generally simple, sometimes scalariform, specially in summerwood.

Vessel segments: 1-2 per mm.

Contents: None.

FIBERS

Dense, more so in the late summerwood.

PARENCHYMA

Paratracheal and *definitely arranged:* not visible; *scattered:* difficult to observe, with gradual changes to very short metatracheal lines.

RAYS

Two kinds with distinct difference in size.

Size: The small ones narrow (15-30 mu), the big ones broad as a rule, sometimes even exceptionally broad and many times broader than the small ones.

Number: Very numerous; the small ones 3 to 4 times as numerous as the big ones.

Height: Small ones extremely low to very low (0.4-0.7 mm.), the broad ones low (1-2 mm.).

Structure: Both kinds made up of flat cells with 1-4 rows of short high cells on the outside, which are sometimes absent in the small ones.

SPECIAL FORMATIONS

None.

EVERGREEN OAK (QUERCUS ILEX L.)

Specific gravity: Heavy (0.82-0.89); *grain:* straight; *cleavability:* splits very difficultly; *luster:* fair; *color:* light brown; *smell:* not characteristic; *taste:* the same; *extract:* yellow brown; *burns:* with comparative difficulty to difficulty, quietly, gives an almost black ash.

Wood Structure

GROWTH-RINGS

Indefinite to fairly definite, the amount of parenchyma and the density of the fibers increase from the springwood to the summerwood. Boundary of the growth-ring is indefinite, but comparatively sharp because of a very narrow row of very dense fibers.

PORES

Grouping: Almost all pores single.

Distribution: In more or less irregular rows, which often branch, some scattered.

Surrounding elements: Touch rays generally on one side, not infrequently on both radial sides as the average distance between the rays is somewhat smaller than the tangential diameter of the biggest and somewhat larger than the smallest pores; otherwise mainly surrounded by fibers and only in some places by parenchyma.

Size: Comparatively small to very small (150-20 mm.) decreasing from springwood to summerwood.

Number: Comparatively numerous (10-20 per square mm.).

Perforations: Simple.

Vessel segments: 2-3 per mm.

Contents: Tyloses.

FIBERS

Very dense, in the neighborhood of the pores not so dense, thus giving the impression of being paratracheal parenchyma.

PARENCHYMA

Paratracheal: Sparse in incomplete masses around some of the pores.

Definitely arranged: Numerous to very numerous, somewhat wavy, often interrupted, connected or disconnected bands of scattered parenchyma.

Scattered: Sparsely as scattered parenchyma here and there aside from the bands.

RAYS

Two kinds with noticeable difference in size. The broad rays are often divided up by rows of fibers which now and then makes them look like bundles of small rays; sometimes a small ray branches off.

Size: The small ones very small (10-20 mu), the broad ones broad to extraordinarily broad (100-450 mu), many times broader than the small ones.

Number: Comparatively numerous to numerous (10-15 per mm., the broad ones 1-5 per cm.). The number of small ones many times that of the big ones.

Height: The small ones very low to extremely low, the broad ones comparatively low to very high (2 mm.-3 cm.).

Structure: Both kinds made of up flat cells only, some of both kinds have a little row of short high or of vertical cells on the outside.

SPECIAL FORMATIONS

None.

OAK (QUERCUS ROBUR EHRH.)

Specific gravity: Comparatively heavy—heavy (0.68-0.8); *grain:* straight; *cleavability:* splits moderately difficult; *luster:* fair; *color:* yellowish brown; *smell:* not characteristic; *taste:* the same; *extract:* brown; *burns:* easily, sometimes snapping, ash not voluminous, dark gray, sometimes contains carbon.

Wood Structure

GROWTH-RINGS

Definite, in the early springwood a broad band of boundary parenchyma, in which are present tangential rows of big pores.

End of year's growth wavelike, very definite, because of the change of the dense fibers of summerwood to the parenchyma of springwood.

PORES

Grouping: Generally single, groups of two exceptionally present.

Distribution: The big pores in tangential rows in springwood, 1-3 pores broad; the small ones in radial or diagonal rows, wavelike and sometimes with branches.

Surrounding elements: The big pores on both sides; the small ones often on one side touching rays, their average distance being many times smaller than the tangential diameter of the big pores, but bigger than the small pores. Pores are surrounded by paratracheal parenchyma.

Size: Obviously two kinds; the big ones comparatively large (200-300 mu), the smaller ones decreasing in size from spring to summerwood from comparatively small to very small (150-20 mu).

Number: Comparatively numerous (average 13 per square mm.).

Perforations: Simple.

Vessel segments: 1-2 per mm.

Contents: Tyloses.

FIBERS[a]

Dense.

PARENCHYMA

Paratracheal: Around practically all the pores. That around the big pores partly united with the boundary parenchyma, that around the small pores forming radially extended flecks.

Definitely arranged: A broad band of boundary parenchyma and also numerous small, wavelike rows, which in the late summerwood changes to scattered parenchyma.

Scattered: Also here and there in other parts of the growth-ring.

RAYS

Two kinds, mainly differing in size.

Size: The small ones very narrow (15-20 mu) the big ones comparatively broad to exceptionally broad (80-400 mu) and many times broader than the small ones.

Number: Numerous to very numerous (13-17 mm.), the small ones many times more numerous than the big ones of which there are only few (1-4 cm.).

Height: The small ones very, very low; the big ones comparatively low to comparatively high (2mm.-2cm.), forming definite flecks on the radial surface.

Structure: All rays are made up of flat cells only, sometimes with short and high cells on the outside. The broad rays sometimes contain fibers in radial rows and may divide themselves into small ones.

SPECIAL FORMATIONS

None.

ELM (ULMUS CAMPESTRIS L.)

Specific gravity: Comparatively light to comparatively heavy (0.50-0.65); *grain:* straight; *cleavability:* splits easily; *luster:* poor; *color:* rose light brown to light brown; *smell:* sour smell of the tanning plant; *taste:* sour, similar to the smell; *extract:* colorless; *burns:* comparatively well, quietly, gives a small amount of gray ash.

Wood Structure

GROWTH-RINGS

Very definite. In the early springwood a tangential row of big pores. The boundary of the ring is sharp, because of a very thin row of terminal parenchyma.

PORES

Grouping: Most of the large pores single, some in groups of two. The small pores nearly always in groups of two to many, arranged in indefinitely shaped clusters.

Distribution: The large pores of the springwood in a tangential row, generally one, sometimes two pores broad near the boundary of the ring.

Surrounding elements: The large pores touch the rays nearly always on both radial sides, the small pores sometimes on both, sometimes on one but generally not at all, since the tangential diameter of the rays is about two-thirds of the tangential diameter of the big pores, but several times bigger than that of the small pores. Elsewhere the pores are surrounded by paratracheal parenchyma.

Size: The large pores comparatively big to comparatively small, the small pores comparatively small to very, very small (125-20 mu).

Number: Numerous, the big pores comparatively few to few (8-3 per square mm.).

Perforations: Simple.

Vessel segments: 3-5, average 4 per mm.

Contents: Thin walled tyloses.

FIBERS

Dense.

PARENCHYMA

Paratracheal: Surrounds the big pores as well as the groups of small pores in a thin layer.

Definitely arranged: As a small row of terminal parenchyma.

Scattered: Absent.

RAYS

One kind.

Size: Comparatively broad to narrow.

Number: Comparatively few (6-7 per mm.).

Height: Low to extremely low.

Structure: Built up of flat cells only.

SPECIAL FORMATIONS

None.

PEAR (PYRUS COMMUNIS L.)

Specific gravity: Comparatively heavy (0.62-0.74); *grain:* straight; *cleavability:* splits easily; *luster:* poor; *color:* rose gray; *smell:* sometimes a little sour, generally not characteristic; *taste:* the same; *extract:* yellowish brown; *burns:* rather well or very well, has a small amount of gray ash.

Wood Structure

GROWTH-RINGS

Indistinct to comparatively distinct, the pores decrease in size more or less distinctly from the springwood to the summerwood. The

boundary of the annual ring is fairly sharp, because of the change of the dense summerwood with few pores, to the less dense springwood.

PORES

Grouping: Almost always single, only a few in groups.

Distribution: Fairly evenly distributed, except in the late summerwood where there are less.

Surrounding elements: When not touched by the rays the pores are surrounded by fibers. The average distance between the rays is slightly larger than the tangential diameter of the pores.

Size: Small to very small (100-25 mm.).

Number: Very numerous (150-200 per square mm.).

Perforations: Simple.

Vessel segments: Not apparent or very difficult to observe.

Contents: None.

FIBERS

Dense.

PARENCHYMA

Sometimes not apparent, sometimes present, but very difficult to observe, as extremely short metatracheal bands or as scattered parenchyma.

RAYS

One kind.

Size: Comparatively narrow, a few comparatively broad.

Number: Numerous (11-15 per mm.).

Height: Very low.

Structure: Made up entirely of flat cells, here and there with 1 or 2 rows short and high, or vertical cells on the outside.

SPECIAL FORMATIONS

None.

APPLE (PYRUS MALUS L.)

Specific gravity: Comparatively heavy (0.66-0.75); *grain:* straight; *cleavability:* splits easily; *luster:* poor; *color:* springwood whitish rose, heartwood brownish red; *smell:* not characteristic; *taste:* the same; *extract:* brownish yellow; *burns:* rather well, gives a voluminous white or yellowish ash.

Wood Structure

GROWTH-RINGS

Vague to comparatively distinct, the pores in the summerwood

somewhat smaller than in the springwood. The boundary of the annual ring is comparatively sharp, characterized by the change of the dense fibers of the late summerwood which is almost without pores, to the less dense springwood in which sometimes the pores close to the boundary form a tangential row.

PORES

Grouping: Almost always single, some in groups.

Distribution: Fairly evenly distributed, except in the late summerwood where there are only a few.

Surrounding elements: When not touching the rays, surrounded by fibers. The average distance between the rays is slightly larger than the tangential diameter of the pores.

Size: Very small to small (25-60 mu).

Number: Very numerous (80-100 per square mm.).

Perforations: Simple.

Vessel segments: Not apparent or very difficult to observe.

FIBERS

Dense.

PARENCHYMA

Not apparent.

RAYS

One kind.

Size: Very small.

Number: Numerous (11-13 per mm.).

Height: Extremely low.

Structure: Entirely made up of flat cells, sometimes with 1 or 2 rows short high or vertical cells along the outside.

SPECIAL FORMATIONS

None.

PLUM (PRUNUS DOMESTICA L.)

Specific gravity: Comparatively heavy to heavy (0.70-0.85); *grain:* straight; *cleavability:* splits comparatively easy; *luster:* fair; *color:* yellowish white with a brown to brown-red heart; *smell:* not characteristic; *taste:* the same; *extract:* colorless; *burns:* fairly well, but forms coal and has no pure ash.

Wood Structure

GROWTH-RINGS

Comparatively distinct, because of the presence of larger pores in

the springwood than elsewhere. The boundary of the annual ring is fairly sharp because of denser fibers in the late summerwood.

PORES

Grouping: Generally single, some in groups of 2-3.

Distribution: Touching the rays generally on one, sometimes on both radial sides. Sometimes surrounded entirely by the fibers, sometimes surrounded by parenchyma.

Size: Very small to very, very small.

Number: Very numerous (180-230 per square mm.).

Perforations: Simple.

Vessel segments: Not apparent.

Contents: None.

FIBERS

Dense.

PARENCHYMA

Paratracheal and *definitely arranged:* Absent.

Scattered: Here and there, difficult to observe.

RAYS

Two kinds, with the main difference in structure.

Size: The small ones very narrow, the bigger ones comparatively narrow to comparatively wide, the bigger ones 3-5 times as wide as the small ones.

Number: Comparatively numerous (average 10 per mm.). The small ones 2 times as numerous as the larger ones.

Height: Very low.

Structure: The small ones entirely made up of vertical and short high cells; the large ones made up of flat cells, commonly with 1-3, sometimes with many rows of short high cells on the outside. Rays including both types occur once in a while.

SPECIAL FORMATIONS

None.

SWEET CHERRY (PRUNUS AVIUM L.)

Specific gravity: Comparatively light to comparatively heavy (0.55-07); *grain:* straight; *cleavability:* splits difficultly; *luster:* fair; *color:* grayish brown to rose brown; *smell:* not characteristic; *taste:* the same; *extract:* light reddish brown; *burns:* well, quietly, gives a small amount of light gray ash.

Wood Structure

GROWTH-RINGS

Rather definite, the size of the pores decreases gradually from the springwood to the summerwood. The boundary of the ring is sharp because of the change of the dense summerwood with a small number of pores to the springwood which is rich in pores and in which the pores near the boundary have a more or less definitely tangential arrangement.

PORES

Grouping: Generally most of them in groups, sometimes a few single.

Distribution: Scattered, the small pores in the late summerwood sparsely, the big ones in the early springwood with more or less definite to tangential arrangement.

Surrounding elements: Pores tough rays generally on one, seldom on both radial sides, or rather often not at all, since the average distance between the rays is considerably greater than the tangential diameter of the pores; fibers form the rest of the surrounding tissue.

Size: Small, to very small in the late summerwood.

Number: Very numerous (70-95 per square mm.).

Perforations: Simple.

Contents: In some a white substance.

FIBERS

Dense.

PARENCHYMA

Paratracheal and *definitely arranged:* Absent.

Scattered: Sparsely as scattered parenchyma or as very short metatracheal bands.

RAYS

Of two kinds, mainly different in structure.

Size: The small ones very narrow, the bigger ones comparatively narrow, several times bigger than the small ones.

Number: Comparatively few (6-7 per mm.), the small ones 1 to 3 times as numerous as the bigger ones.

Structure: The small ones made up entirely of vertical, sometimes very short and high cells. The bigger ones as far as they are single made up from flat cells with one to three rows of short high cells on the outside. Rays of both kinds combined occur not infrequently.

SPECIAL FORMATIONS

Generally absent. Sometimes gum ducts are found.

ACACIA (ROBINIA PSEUDOACACIA L.)

Specific gravity: Heavy (0.75-0.86); *grain:* straight; *cleavability:* splits comparatively difficultly; *luster:* marked; *color:* greenish yellow; *smell:* not characteristic; *taste:* the same; *extract:* light yellow, in alcohol reddish brown; *burns:* comparatively difficultly, quietly, gives a rather voluminous, white ash.

Wood Structure

GROWTH-RINGS

Definite; rather large pores close together in the springwood; in the rest of the growth-ring smaller pores which decrease in number towards the late wood. The boundary of the ring is sharp because of terminal parenchyma which is very closely linked with the paratracheal parenchyma around the big pores in the early springwood.

PORES

Grouping: Generally single, sometimes in groups of 2-4; in the summerwood near the pores are tracheids, which resemble a coarse parenchyma tissue.

Distribution: Close together in a band, about 3 pores broad in the springwood, in the rest of the ring scattered; in the late wood sometimes locally arranged in very short tangential rows.

Surrounding elements: Pores touch rays commonly on one, often also on both radial sides, the distance between the rays being smaller than the large pores and larger than the small pores; paratracheal parenchyma forms the rest of the surrounding tissue.

Size: Comparatively large to small or very small (300-50 mu or 30 mu); the size decreases gradually from the spring to the summerwood.

Number: Few (4 per square mm.).

Perforations: Simple; difficult to observe because of the so frequent tyloses.

Vessel segments: Difficult to observe.

Contents: Numerous tyloses.

FIBERS

Dense.

PARENCHYMA

Paratracheal: As a small complete layer round most of the pores, at the boundary of the ring forming terminal parenchyma.

Definitely arranged: Absent.

Scattered: As very short, rather narrow bands frequently linked to the paratracheal, mainly in the summerwood; sparse.

RAYS

One kind.

Size: comparatively small.

Height: Extremely low to very low.

Number: Few to comparatively few (5-7 per mm.).

Structure: Made up of flat cells entirely.

SPECIAL FORMATIONS

Storied parenchyma and segments of pores, difficult to observe. No other special formations.

BASSWOOD (TILIA GRANDIFOLIA EHRH.)

Specific gravity: Light to comparatively light (0.4-0.6); *grain:* straight; *cleavability:* cuts easily; *luster:* poor; *color:* reddish white to yellowish white; *smell:* not characteristic; *taste:* the same; *extract:* colorless; *burns:* well, quietly, gives a gray ash.

Wood Structure

GROWTH-RINGS

Rather indefinite to comparatively definite. The boundary of the ring comparatively sharp because of denser fibers in the late summerwood and a more or less definite tangential row of the pores in the early springwood.

PORES

Grouping: Generally single, also in groups of 2-6, sometimes these groups are in the majority.

Distribution: Scattered, except a more or less definite tangential row of pores in the early springwood.

Surrounding elements: Generally surrounded by fibers entirely. A number touches on one radial side a ray. The distance between the rays is about 3 times as big as the tangential diameter of the pores.

Number: Very numerous (80-120 per square mm).

Perforations: Simple.

Vessel segments: Difficult to observe.

Contents: None.

FIBERS

Not very dense to comparatively dense; denser in the late summerwood.

PARENCHYMA

Paratracheal and *definitely arranged:* Are absent or at least not apparent.

Scattered: Scattered parenchyma, gradually changes to very, very short and very small metatracheal rows.

RAYS

One kind.

Size: Comparatively small.

Number: Few to comparatively few 4-6 per mm.).

Height: Very low to extremely low.

Structure: Made up from flat cells, generally with one row short high cells along the outside.

SPECIAL FORMATIONS

None.

BOXWOOD (BUXUS SEMPERVIRENS L.)

Specific gravity: Very heavy (0.91-1.0); *grain:* somewhat wavy; *cleavability:* splits with difficulty; *luster:* poor to fair; *color:* light yellow; *taste:* not characteristic; *smell:* the same; *extract:* colorless; *burns:* with difficulty, ash not voluminous, white or whitish gray.

Wood Structure

GROWTH-RINGS

Not very clear, near the end of the annual ring pores are absent. The boundary is comparatively definite because of a row very dense fibers.

PORES

Grouping: Generally single, exceptionally groups from 2-4.

Distribution: Scattered, except in the above mentioned zone, which is distinct from the pores.

Surrounding elements: Pores generally touching two rays, as the tangential diameter is about the same as the distance between the rays.

Size: Very, very small.

Number: Very numerous (160-200 per mm.).

Perforations: Scalariform.

Vessel segments: Scarcely observable.

Contents: Not observable.

FIBERS

Very dense.

PARENCHYMA

Paratracheal and *definitely arranged:* Cannot be seen or is absent.

Scattered: With gradual changes to fine short metatracheal rows.

RAYS

Two kinds, mainly differing in structure.

Size: The small ones very narrow, the comparatively large ones narrow and 2-3 times as broad as the small ones.

Number: Numerous (12-13 per mm.), the small ones 1-2 times as numerous as the larger ones.

Height: Extremely low.

Structure: The small ones made up of vertical cells only, the big ones of flat cells with several rows of vertical cells. Sometimes combinations of both kinds.

SPECIAL FORMATIONS

None.

SYCAMORE (ACER PSEUDOPLATANUS L.)

Specific gravity: Comparatively light—comparatively heavy (0.53-0.68); *grain:* straight; *cleavability:* splits easily; *luster:* fair; *color:* yellowish white; *smell:* not characteristic; *taste:* the same; *extract:* colorless; *burns:* rather well, quietly, gives a rather voluminous ash.

Wood Structure

GROWTH-RINGS

Comparatively definite. The boundary of the ring fairly sharp because of a row dense, dark colored fibers near it.

PORES

Grouping: Generally single, also in groups of 2-6; sometimes locally these groups are in the majority.

Distribution: Fairly evenly distributed, often a little less in the summerwood.

Surrounding elements: Generally surrounded by fibers entirely, now and then touching a ray on one radial side, as the average distance between the rays is several times as great as the tangential diameter of the pores.

Size: Small.

Number: Numerous (20-35 per square mm.).

Perforations: Simple.

Vessel segments: 1-2 per mm.

Contents: None.

FIBERS

Not very dense to comparatively dense.

PARENCHYMA

Paratracheal and *scattered:* Very difficult to observe.

Definitely arranged: Absent.

RAYS

One kind.

Size: Very small to broad, the size varies considerably, but all gradations of change are present, hence cannot be divided in two kinds of rays.

Number: Comparatively few (6-7 per mm.).

Height: Extremely low to very low.

Structure: Made up entirely of flat cells, in some rays short, high cells occur also.

SPECIAL FORMATIONS

None.

HORSE CHESTNUT (AESCULUS HIPPOCASTANUM L.)

Specific gravity: Comparatively light—comparatively heavy (0.52-0.63); *grain:* straight; *cleavability:* splits easily; *luster:* warm; *color:* cream white to yellowish white; *smell:* not characteristic; *taste:* the same; *extract:* colorless; *burns:* rather well, quietly, gives a gray ash.

Wood Structure

GROWTH-RINGS

Fairly definite, the diameter of the pores decreases somewhat in the summerwood; in the earliest springwood the pores are arranged in a tangential row close to the boundary of the ring, which is sharp because a band dense and light colored fibers in the late summerwood.

PORES

Grouping: Generally single, also in groups from 2-4.

Distribution: Scattered except a more or less definite tangential row in the early springwood.

Surrounding elements: Pores generally on one, sometimes also on both radial sides touching the rays, as the average distance of the rays is somewhat larger than the average tangential diameter of the pores; fibers form the rest of the surrounding tissue.

Size: Very small.

Number: Very numerous (80-140 per square mm.).

Perforations: Simple.

Vessel segments: 4-8 per mm., difficult to observe.

Contents: Not observable.

FIBERS

Dense.

PARENCHYMA

Paratracheal and *definitely arranged:* Not apparent.

Scattered: Present through the whole annual ring.

RAYS

One kind.

Size: Very small.

Number: Very numerous (16-20 per mm.).

Height: Extremely low.

Structure: Made up of flat cells only.

SPECIAL FORMATIONS

None.

ASH (FRAXINUS EXCELSIOR L.)

Specific gravity: Comparatively heavy to heavy (0.6-0.87); *grain:* straight, sometimes slightly wavy; *cleavability:* splits rather difficultly; *luster:* definite; *color:* light brownish white to dingy white; *smell:* not characteristic; *taste:* the same; *extract:* colorless; *burns:* rather well, quietly, has a white ash.

Wood Structure

GROWTH-RINGS

Very definite. In the springwood a rather broad band of rather large pores; elsewhere the size of the pores decreases towards the late summerwood. The paratracheal parenchyma is very definite in the summerwood. The boundary of the growth-ring is sharp because of a comparatively small band of terminal parenchyma.

PORES

Grouping: The big pores in the springwood generally single, also in groups of 2 or 3; the small pores in the late summerwood generally in groups of 2 or 3. Generally over the whole single.

Distribution: The big pores in the springwood in a broad tangential row, the small pores in the summerwood in short, wavelike, more or less tangential rows, the rest scattered.

Surrounding elements: The rays are touched by the big pores, generally on both sides, often on one side by the smaller ones and not at all by the smallest ones. Pores also surrounded by paratracheal parenchyma.

Size: The big pores comparatively large to comparatively small (300-150 mu), the small pores comparatively small to very small (150-20 mu), with gradual changes.

Number: On an average comparatively few, varying from few in the springwood to comparatively numerous in the summerwood.

Perforations: Simple.

Vessel segments: 4-6 per mm.

Contents: Tyloses.

FIBERS

Dense, the density increases from the springwood to the summerwood.

PARENCHYMA

Paratracheal: As narrow to comparatively wide layers round almost all the pores; the layers in the springwood more complete and wider.

Definitely arranged: As terminal in a comparatively narrow band on the boundary of the ring and as one or more similar bands in the late summerwood. These bands originate from the linking up of the longer bands of the paratracheal parenchyma with the scattered parenchyma which is frequent in the summerwood.

RAYS

One kind.

Size: Comparatively small.

Number: Comparatively numerous (8-10 per mm.).

Height: Generally extremely low, exceptionally very low (0.6 mm.).

Structure: Made up from flat cells only.

SPECIAL FORMATIONS

None.

IDENTIFICATION

A key should meet the following requirements:

a. It should be dichotomous.

b. When there is a likelihood of making certain mistakes, both ways should finally lead to the same end.

c. Characteristics of determination should be shown according to their successive importance[15] so as to bring closely related genera to-

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[15]The use of "easy" characteristics, such as rings, ringporousness as chief characteristics is not desirable as they are of secondary importance from the botanical systematical point of view, and because in closely related or even the same genera they can vary widely.

gether in the key. Only in this way can the determination of woods which are not described in the key be found in relation to their nearest relatives. For final identification one should use the detailed descriptions of the species.

The larger the key, the more important are the above requirements. They are followed below in this comparatively small key.

KEY

1. Vessel perforations, all (or most of them) simple............ 2
   Vessel perforations, all (or most of them) scalariform..... 9
2. Rays uniform 3
   Rays of two kinds....................................12
3. Paratracheal parenchyma absent or very difficult to observe..... 4
   Paratracheal parenchyma present and more or less clearly noticeable around most of the pores.........................16
4. Rays very narrow or narrow, not wider than 30 mu........... 5
   Rays with a width of more than 30 mu are frequent......... 7
5. Largest pores are small or comparatively small, radial diameter more than 50 mu; wood white or yellowish white. *Poplar* (Populus sp.)
   Largest pores have a radial diameter below 50 mu.......... 6
6. Rays numerous (10-14 per mm.), colored reddish brown with eventually one row of short, high cells on outside (heterogeneous); pith flecks nearly always present. *Willow* (Salix sp.)
   Rays very numerous (16-20 per mm.) colored white built up of flat cells only (homogeneous); pith flecks nearly always absent. *Horse chestnut* (Aesculus sp.)
7. Terminal parenchyma present as a small row; scattered parenchyma easily noticeable as numerous, short, very thin lines..... 8
   Terminal parenchyma absent. Scattered parenchyma not or hardly noticeable 18
8. Pores generally single, comparatively few and comparatively small to comparatively large; number of rays comparatively numerous (8-10 per mm.); heartwood brown, gray-brown, often violet-brown. *Walnut.*
   Pores generally in groups from few to many, comparatively numerous, very small to small; number of rays very numerous (12-17 per mm.); heartwood grayish-white to brownish-white. *Blue beech* (Carpinus sp.).
9. Rays comparatively numerous (maximum 10 per mm.). *Birch* (Betula sp.).
   Rays numerous to very numerous (11-17 per mm.).........10

10. Pores generally in definitely radial groups. *Hazel* (Corylus sp.)
Pores generally single....................................11

11. Rays built up of flat cells only; pith flecks rather numerous; specific gravity wood less than 0.6. *Alder* (Alnus sp.).
Rays entirely or partly built up from vertical cells; wood very heavy (sp. gr. greater than 0.8). *Boxwood* (Buxus).

12. Both kinds differ in size, but not in character of building cells (homogeneous) 13
Main difference between both kinds of rays, due to the fact that the narrower rays are built up from vertical (or short high) cells (heterogeneous) 21

13. Pores generally in groups; rays very numerous (12-17 per m. m.), always extremely low (less than ½ mm.); the broader kind of rays seem to be of a second type only, they are compound rays; pores gradually decreasing in size from spring to late summerwood. *Blue beech* (Carpinus sp.).
Pores generally single 14

14. Paratracheal parenchyma absent or not distinguishable; pores not in radial rows; rays very numerous (16-17 per mm.); pores very small and very numerous (100 per mm.^{2}) *Beech* (Fagus sp.).
Paratracheal parenchyma clearly visible; pores specially in springwood in radial rows....................................15

15. Pores maximum comparatively small (less than 150 mu), in gradually decreasing size in the direction of the late wood of the year's growth; no tangential rows in springwood. *Evergreen oak* (Quercus Ilex).
Pores clearly of 2 different kinds of size, the larger ones comparatively large (up to 300 mu) and in a tangential row in the springwood. *Oak* (Quercus sp.).

16. The small pores in summerwood in big groups together and in definite tangential arrangement. *Elm* (Ulmus sp.).
The small pores in summerwood all or nearly all scattered....17

17. Rays extremely low to very low; storied wood parenchyma (not storied rays); wood color greenish yellow. *"Acacia"* (Robinia sp.).
Rays all extremely low; no storied formation; color of wood whitish to light brown. *Ash* (Fraxinus sp.).

18. Rays few or comparatively few (4-7 per mm.), color of wood yellowish white 19
Rays comparatively numerous to very numerous (8-16 per mm.), color of wood very light brownish gray, to clearly brownish red 20

19. Part of rays are comparatively broad to broad (50-150 mu); number comparatively few (6-7 per mm.); pores numerous (20-35 per mm.^{2}). *Sycamore* (Acer pseudoplatanus).
    Rays maximum comparatively narrow (maximum 50 mu); few to comparatively few (4-6 per mm.); pores very numerous (80-120 per mm.^{2}). *Basswood* (*Linden*) (Tilia sp.).
20. Pores more than 150 in a square mm., color of wood very light brownish gray. *Pear* (Pyrus sp.).
    Pores 80-100 per square mm.; heartwood brownish red, sapwood light brown. *Apple* (Pyrus sp.).
21. Pores generally single, generally more than 180 per mm.^{2}. *Plum* (Prunus sp.).
    Pores generally in groups, generally less than 180 per mm.^{2}; sometimes in springwood tendency to formation of a tangential row. *Cherry* (Prunus sp.).

CONCLUSIONS

The detailed descriptions of woods have been given in this paper for the purpose of showing how reference to them can make identification easier. It is also important to note that while studying the wood structure with a hand lens of 10X magnification it is possible to gather several significant indications about the technical qualities of the woods. One of us has already extensively published on the relation between microscopical structure and technical properties[16] and showed how it is possible to derive the specific gravity from the structure.

Looking at photographs of such woods as poplar and willow, immediately gives one the impression that these are light woods. Comparing them with beech, a person might be inclined to consider *beech* also as a wood of light specific gravity, because of its great number of pores, were it not for the heavy fibrous material which indicates that this wood will be heavier than willow. Among other woods with a dense fibrous structure it is obvious on inspection of photomicrographs for instance, that elm must be comparatively light; oak and "acacia" comparatively heavy to heavy; and evergreen oak still more heavy.

Some idea of the porosity of different woods can be formed by determining the presence or absence of tyloses, which in several woods fill up the most important water conducting channels. From this it fol-

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[16]J. Ph. Pfeiffer: l. c., pp. 243-248.

lows that poplar and beech are very porous, ash and "acacia" not so porous.

Compared with birch and Carpinus, beech has rather broad and definite rays. These account for the greater cleavability in radial direction found in beech as compared with the two others.

In these simple examples the main choice has been made from more or less similar woods. This was done because often different details in structure influence one and the same technical quality, thus making less clear the relation between the two. This paper, however, is not the place to go into this matter. The method here discussed not only gives easy means of discrimination, but it also permits one to derive connections between structure and botanical relationships. Although the structural differences of these European hardwoods are not as noticeable as those in tropical woods, obvious differences are found here. This will be seen if walnut, elm, "acacia," maple and ash are compared. All these, however different amongst themselves, form a sharp contrast to finer textured woods such as boxwood and horse chestnut.

The key shows, moreover, that even closely related woods of very similar structure, such as pear and apple, and plum and cherry offer sufficiently different characteristics to be told apart. Others, like poplar and willow, oak and evergreen oak also illustrate a very close respective similarity in structure in closely related genera. In the case of the latter two, the presence in the one and the absence in the other of a tangential row of big pores in springwood is noteworthy. This difference finds its origin in the fact that evergreen oak, growing in southern Europe, is an evergreen. At the same time, this is an instance in two very closely related species, which shows of what little importance, as main characteristics so-called "ringporousness" offers. This example could easily be multiplied.

It is not meant, on the other hand, that botanically important characteristics will always remain unchanged in the same family. On the contrary, characteristics constant in several families vary in others, as they do in systematic botany.

Ordinarily, these changes are rather gradual. Thus beech and oak, both belonging to the Fagaceae, both have two kinds of rays (narrow and broad). Chestnut (not considered in this paper), closely related to oak, has broader rays only in its early growth; in the later formed wood only small rays are normally found. In the family of the Betulaceae, related to Fagaceae and to beech specially, there is another case, as can be seen in alder and hazel. On superficial observation it seems as if

small *and* broad rays were present. Closer examination, however, shows that the broad rays are composed of bundles of small ones (aggregated), very close to each other, with sometimes fibers and parenchyma in between, but never pores. In hazel they are very clear; in alder much less pronounced and already in smaller numbers. In hornbeam, belonging to the same family as birch, there is but a vague indication of rays placed in bundles (aggregated); in birch every such indication is lacking. These "rays in bundles" perhaps have no special systematic value; their relation to the far more important, genuine, broad rays in beech and oak is however unmistakable. The different relationships within the family of Betulaceae find their expression in the wood structure too. The close relation between hazel and hornbeam follows from the distribution of pores and the presence of numerous, very short rows of scattered parenchyma. Both belong to the tribe Coryleae, as compared with alder and birch, which belong to the tribe Betuleae. This is clear from the transverse surfaces of alder and birch, both of which very frequently also have pith flecks.

That between families there are intermediate forms is illustrated in Betulaceae and Fagaceae by alder and hazel on the one side and beech on the other. Besides the above mentioned difference in rays, it is noted that in the Betulaceae the perforations of pores are generally scalariform, in Fagaceae generally simple. Beech is an exception, inasmuch as it has, in addition to simple, also scalariform perforations, specially in the summerwood. In the family of Betulaceae, hornbeam is different, as it has simple perforations too. Thus it is apparent that this so extraordinarily important and constant characteristic in some other families becomes all at once inconstant. Notwithstanding these exceptions, confusing in the beginning, a systematic study shows that the variations in wood-structure link themselves very well to the results of systematic botany. It is also apparent that the successive importance of characteristics is sometimes different in different families.

Thus is it shown, be it for a comparatively small number of woods, that with a right choice of characteristics it is possible to produce a key which in its main lines runs parallel to the botanical order.

This follows too from the fact that woods not described in it, but closely related to those described can be identified as such close relatives. This has been tested on several North American hardwoods: Beech (*Fagus atropunicea* Marsh), Maple (*Acer saccharum* Marsh), River Birch (*Betula nigra* Linn), Basswood (*Tilia americana* Linn), Yellow Buckeye (*Aesculus octandra* Marsh), White Ash (*Fraxinus americana*

Linn), White Oak (*Quercus alba* Linn), White Elm (*Ulmus americana* Linn).

Comparing structure and physical properties of these woods with the detailed descriptions, gives in a great majority of cases sufficiently pronounced differences to conclude that such specimens are closely related though not identical with those described.

During this work a substitute boxwood was encountered, that had been declared genuine *Buxus sempervirens* by experienced practical handlers of wood. The radial face showed at once on hand lens examination, however, that the perforations of pores were simple instead of scalariform. This wood could thus not be *Buxus sempervirens,* but must belong to a different family or genus.[17]

Thus it seems apparent, as has been indicated, that there is now available, by the method described, a sufficiently worked out system, good and simple for practical wood identification with the aid of a hand lens. It is further maintained that this method for technical-scientific purposes practically equals the more elaborate and time-consuming microscopical methods. Therefore, it is here presented for the consideration of all who have to do with wood and its identification.

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[17]Further research showed this was *Casearia preacox* Griseb (West Indian Boxwood), family of Flacourtiaceae.

RUBBER PLANTATIONS AS A FOREST RATHER THAN HORTICULTURAL INDUSTRY

By A. H. Muzzall, M. S. F.

INTRODUCTION

Hevea Braziliansis, the producer of plantation rubber, is a forest tree. It was taken from its native habitat in the mixed forests of the Amazon Valley to the Middle East and planted in pure stands. In the early days of the plantation industry in the British and Dutch colonies, the trees were planted fairly close together, usually 200 to 300 and even 400 per acre. Little was known about the tolerance of the rubber tree and the planters naturally wanted to get as many per acre as possible. These early plantations were not given much care, many were planted on newly cleared jungle land on which the old jungle stumps and roots were allowed to remain. As the trees grew and established a dense crown cover, the struggle for light naturally caused a deadlock. This deadlock weakened the vitality of the tree so that it was not able to put on renewed bark after tapping as fast as trees planted less densely. disease did more damage, and the yield of latex fell off. This falling off of yield and backward trend of the trees began at different ages according to site conditions and density of planting.

As time went on enormous profits were realized and a great impetus was given the rubber plantation industry. A great deal of money was spent in studying the conditions affecting growth of the trees, yields of latex, and diseases. But, while all this investigation was going on, thousands of acres were being planted, and the planters seeing the backward trend of the plantations that were planted closely, decided that it was better to plant fewer trees per acre, so we now have many hundred thousand acres of rubber plantations, whose planting distances gave less than 200 trees per acre and a great many, only a hundred per acre. If these areas were jungle land, the stumps were removed and the soil cultivated so that very little of the jungle wood remained. The plantations were clean weeded; terraces, and blind drains constructed, and cover crops established. In fact, a veritable landscape garden was developed. All this cost money, meaning an investment from 200 to 400 dollars per acre, but rubber was yielding big returns even on this investment. Then came the big drop in prices and today there are several hundred million dollars invested which have not had a profitable

return for several years. Planting must go on to take care of the future and the question arises, should the planting industry continue on the present elaborate system of cultivation and wide planting, with the large amount of capital invested, or should it go back to its original close planting methods and low capital investment?

PALEMBANG DISTRICT—SUMATRA

(A Malay rubber grove the dense planting keeps the undergrowth down and the trees small.)

NATIVE PLANTATIONS

This brief outline of the history of rubber planting applies only to European plantations. Chinese and natives of the British and Dutch Colonies in the Middle East have also gone in for rubber planting, and today, the natives of the Dutch Colonies produce about one third of the total out-put of these colonies. The native methods of planting and

caring for the plantations are different from those of the Europeans and correspond more closely to forest management than to horticultural practice.

NATIVE METHODS

When the native plants on jungle land, he falls the timber and burns up what he can. There is no digging out of stumps or roots, he plants

Two and one half year old trees, planted 96 per acre weeded every month at an annual cost of about $5 per acre. The cover crop is to prevent soil wash.

the rubber trees at given intervals among the old stumps. Sometimes he plants them in rows, but often he just scatters them around. The number per acre varies from about 300 to as high as 600, usually around 500. After this is done, he plants rice, tapioca, and other foodstuffs for a couple of seasons. At three years of age the rubber trees have grown so that they shade the ground fairly well. At five years the

stand is so dense that no grass or jungle shrubs can grow underneath and there is no need for constant care to keep them down as there is in the widely planted European plantations. The deadlock naturally takes place much sooner than it did in the more widely planted estates, but on the other hand, the yields per acre of the first few years are much greater where there are so many more trees. The age at which the plantation begins to go backward varies according to the density and the site. This has never been accurately worked out, but planters with long experience have a general idea.

RESULTS OF RESEARCH IN RUBBER PLANTING

We still know very little about the rubber tree, what latex is, its function in the tree, what Brown Bast is (one of the most serious ailments affecting production) are still to be found out. The few outstanding things that we do know are:

1—That an area planted over 200 trees per acre begins to go backward somewhere around ten years of age unless some thinning is done.

2—That about one third of the trees are not worth tapping and these trees can be determined by measuring their production of latex ten to twenty times at given intervals.

3—That root disease attacks some of the trees on certain sites and kills them. A percentage of the trees are resistant to root disease and thrive when the surrounding trees are killed. Brown Bast can be controlled by resting, light, and intermittent tapping.

4—That good bark renewal is dependant on site and density.

5—That removing all the stumps and roots from the ground as a method of eradicating root disease has never been proven a paying proposition.

6—That by budding from proven strains of high yielding stock, yields per acre can be increased at least 25% over ordinary stock.

PROPOSED METHOD OF PLANTING AND MANAGEMENT

In the writer's opinion, a planting company starting development of rubber plantations, should select land free from jungle or at least with secondary jungle on it and plant the trees at least 300 per acre. Food stuffs should be raised between the trees the first few years or else a cover crop established so that there would be little cost for upkeep

until the trees formed a dense crown cover. This dense cover should be maintained by careful thinning so that the trees are not stunted, but so as to keep the undergrowth from gaining headway. If practical, budded stock should be used. The thinning should always be done according to yield and only the poor yielders or diseased trees removed. In removing the worthless trees, they should merely be cut off close to the ground, as digging out the stumps is a great expense and even if

8 year old trees planted about 160 per acre, Note small amount of Undergrowth.

they were taken out, it is impossible to take out all the lateral roots which would do as much harm as the stumps. This method of thinning has been used in many places and no evil results have been noted.

In localities where the market permitted it (such as the Philippines) cattle should be used to graze among the trees thus aiding in the upkeep and affording an additional source of revenue.

This briefly outlined method would mean an invested capital of about one half that of the widely planted and costly maintained plantation of the F. M. S. and Sumatra. It would be more like the native gardens except that the planter would take advantage of the existing knowledge of the rubber tree and keeping it growing under conditions

of opitimun density and greater yield per acre. Natives in Sumatra bring in two to four times as much rubber per acre between the fourth and eighth years of the life of the trees, as the European plantations, but their plantations quickly fall off in yield after the tenth to fifteenth year. If they thinned out the worthless trees, the remaining ones would do better and this falling off would be postponed.

Another method would be to tap the trees until they ceased to pay and remove them, making place for a new plantation. Figuring the life of the trees as ten years, a regular rotation could be established so that yield of the plantation would be stable. The cost of cutting down and burning the old worn out blocks would not be any greater than clearing

secondary jungle land and the planter would have the advantage of being able to improve his stock and utilize the knowledge the industry is constantly gaining and is unable to use as the plantations are being managed on a long time rotation.

ADVANTAGE OF THE FORESTRY METHOD OF HANDLING RUBBER PLANTATIONS

1—Low capital investment.
2—Quicker returns due to bigger yields in the early life of the plantation.
3—Lower costs of upkeep.
4—Ability to take advantage of the new methods of improving of the planting stocks.
5—Can follow the trend of the fluctuating market to better advantage.

A STUDY OF MORTALITY AND RECOVERY AFTER LOGGING

By H. C. Belyea,

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The following study was undertaken for the purpose of acquiring some information regarding the degree and duration of mortality, i. e., the death of trees surviving after lumbering. The study is based on data acquired in the intensive examination of four permanent sample plots, established in the vicinity of Cranberry Lake, St. Lawrence County, New York. It is realized that any conclusions derived are but local in importance until checked by results from other logging operations further afield. In view of which consideration, the results submitted herein should only be regarded as a preliminary report to a larger and broader study to be undertaken in the near future.

PERMANENT SAMPLE PLOT NO. I

This plot was located in the Mixed Hardwood type about one mile southeast of the village of Wanakena, St. Lawrence County, New York. It was established in May-June 1919 and remeasured in August-September, 1922. The site is typical Mixed Hardwood land situated on a bench about 200 feet above the valley with an absolute elevation of approximately 1,700 feet above sea level. The ground is generally level or slopes gently to the southwest. The drainage of the plot is excellent, assisted no doubt by the fact that just below the plot the slope breaks very abruptly downward toward the valley.

Up to the winter of 1907-08 the site of this plot was virgin forest. At that time it was lumbered for both hard and soft wood. According to the standards of utilization of the lumber operator, as testified to by the stumps, this meant that hardwoods were cut to approximately 10 inches, DBH measurements. Considerable inconsistency in the removal of softwood trees is revealed by the fact that the cutting limit seems to have varied from 4 to 8 inches DBH, the conclusion being that the loggers were guided quite as much by expediency, and by their judgment of the value of individual trees rather than by an adhesion to a strict diameter limit.

That the lumbering operation can hardly be designated a clear cutting proposition is evidenced by the fact that only about 2/5 of the stand was removed, leaving 103 stems per acre, 4 inches DBH and over, out

of the original 183, standing on the site at the conclusion of the logging. It might be noted in passing that the cutting was relatively much heavier in the softwood portion of the original stand, the result of which would inevitably presuppose a very positive trend toward a purer hardwood type in the second growth forest.

Following the logging operation, the area was left to recover. That this recovery, at least for the period covered by the next ten years was negative in character is revealed by the fact that in this time some 41 stems, 4 inches DBH and over died, either due to natural agencies of decay or were windthrown. Between 1919 and 1922 eight more stems disappeared from the living stand. On this particular site windthrow was of minor importance, only about 30% of the total mortality being due to this factor. In other words, out of the 103 stems, 4 inches DBH and over, surviving the logging operation some 41 stems, 4 inches DBH and over, disappeared in the first ten years and 49 stems in the first fourteen years. In other words this plot shows an annual mortality percent, based on the original surviving stand of 3.4%.

When does recovery take place? Briefly when growth balances or counter balances decay or deterioration. According to McCarthy (8), Chandler (2), Belyea (6) the initiation of recovery from suppression as evidenced in increased growth in surviving members of a stand following a logging operation, does not take place for a period of from four to eight years after the removal of the commercial stand. During this period it is to be expected that the numbers dropping out of the surviving stand will greatly exceed the number growing into it from the small diameter 2 and 3 inch DBH classes. On this particular site, during the first ten years after the logging, there is not sufficient increase in increment as indicated from borings to attest an appreciable entry into the stand through growth in numbers from the small diameter classes. Between 1919 and 1922 some 53 trees grew into the 4 inch DBH class from the smaller sized classes, thus quite counter balancing the loss of 8 members in the same period. The net result of which is that in 1922 we find the site supporting 107 trees, 4 inches DBH and over per acre, as opposed to the 103 trees per acre immediately surviving the logging operations. Definite recovery and progress toward the original formation, at least in number of stems per acre, seems clearly connoted.

It is to be expected that the number of stems per acre will sooner or later be increased in numbers to a total stand per acre greater than that of the virgin stand and then be decreased through processes of natural competition to a total somewhere approximately the same as that of the

TABLE I

Sample Plot No. 9 11 18
New York State College of Forestry Series
Mixed Hardwood Type—Logged for Hard and Softwood in Winter of 1908-09
Area 1 Acre

	All of the trees per acre 4 inches DBH and over standing in the original forest in Sept. 1907		Less trees per acre 4 inches DBH and over. Removed in the logging operation—winter of 1907-08		Equals trees per acre 4 inches DBH and over standing in area in May 1908		Less the trees per acre 4 inches DBH and over which died, dropped and disappeared between May 1908 and May 1919		Equals trees per acre 4 inches DBH and over standing on the area in May 1919		Less the trees per acre 4 inches DBH and over which have died and disappeared between May 1919 and Sept. 1922		Plus trees per acre 4 inches DBH and over which have grown into stand from the 2 and 3 inch DBH classes		Equals trees per acre 4 inches DBH and over standing on area in Sept. 1922	
	No.	%*	No.	%*	No.	%*	No.	%*	No.	%*	No.	%*	No.	%*	No.	%*
Spruce	75	41.0	40	21.9	35	19.1	10	5.5	25	13.6	1	0.5	9	4.9	33	18.0
Hemlock	4	2.2	2	1.1	2	1.1	...	....	2	1.1	...	....	...	....	2	1.1
Yellow Birch	24	13.1	13	7.1	11	6.0	7	3.7	4	2.2	...	....	...	....	5	2.7
Soft Maple	6	3.2	4	2.2	2	1.1	1	0.5	1	0.5	...	....	1	0.5	1	0.5
Hard Maple	20	11.0	4	2.2	16	8.8	6	3.2	10	5.5	2	1.1	...	....	8	4.4
Beech	53	29.0	16	8.8	37	20.2	17	9.3	20	11.0	5	2.7	10	5.5	25	13.7
Black Cherry	1	0.5	1	0.5	...	....	...	....	...	....	...	....	2	1.1	2	1.1
Fire Cherry	...	....	...	....	...	....	...	....	...	....	...	....	31	16.9	31	16.9
Total	183	100.0	80	43.8	103	56.5	41	22.4	62	33.9	8	4.4	53	29.9	107	58.5

*Percent figures based on total number of trees 4 inches DBH and over per acre in the original forest.

climax formation for the site. Space does not permit any analysis of the probable composition of the second growth forest beyond indicating that it will approximate more nearly a pure hardwoods forest. As pointed out by Baker and McCarthy (3) there will probably be much heavier representation of Yellow Birch and Black Cherry than in the original forest.

The history of the deterioration in numbers of this forest and of the others here considered as represented by the sample plots, and subsequent recovery is graphically portrayed in the accompanying figure to which attenion is called. In this particular case recovery seems to date from the year 1919-1920 and although fourteen years after the logging operation mortality in survivors still continues, its severity is decreased and its loss more than counterbalanced by vigorous growth.

B—PERMANENT SAMPLE PLOT II

This plot is located about one-half mile southeast of the village of Wanakena, St. Lawrence County, N. Y. It is located in the Spruce Flat type logged over for both hard and softwood in 1907-08. The site of the plot is representative of the type being on level or gently sloping land situated between the spruce swamp below and the mixed hardwood land above. The occurrence of a considerable percentage of Beech in this plot is believed to be due to the seizure by that species of drier and better drained hummocks occurring irregularly throughout the area. Slope and exposure is toward the west. The soil, a sandy gravelly loam, is somewhat shallow and there is present some loose rock and scattered boulders.

The original forest in virgin condition contained some 253 stems of all species, 4 inches DBH and over, of which number some 66% belonged to the softwood species. The logging operation removed only 85 trees (i. e., 33.6% of the stand) 17% of which number were hardwoods. Of the 168 trees remaining after the cutting, during the next fourteen years (i. e., between 1908-1922), some 101 stems or 60% of the surviving forest died or dropped out of the stand. The annual mortality percent is 4.3. Between 1919 and 1922 some 19 trees have grown up into the 4 inch DBH from the 2 and 3 inch DBH classes below, but this does not balance the 23 stems which dropped out of the stand in the same period. While the process of deterioration has been checked, it has not yet been balanced or counterbalanced by growth. Expectation is that within the next two or three years this will take place, but until it does take place it cannot be said that definite recovery has been initiated.

TABLE II

Permanent Sample Plot 9 11 19
New York State College of Forestry Series
Spruce Flat Type—Logged for Hard and Softwood in Winter of 1907-1908
Area 1 *Acre*

	Trees per acre 4 inches DBH and over standing in original forest in May 1907—previous 8 logging operations		Less trees per acre 4 inches DBH and over. Removed in logging operations in winter of 1907-1908		Equals trees per acre 4 inches DBH and over standing in area in May 1908 immediately after the logging operation		Less trees per acre 4 inches DBH and over which died or disappeared from the stand between May 1908 and May 1919		Equals trees per acre 4 inches DBH and over standing on area in May 1919		Less trees per acre 4 inches DBH and over which died and disappeared from the stand between May 1919 and Sept. 1922		Plus trees per acre growing up with the stand from the 2 and 3 inch DBH classes between May 1919 and Sept. 1922		Equals trees per acre 4 inches DBH and over standing on the area in Sept. 1919	
	No.	%*	No.	%*	No.	%*	No.	%*	No.	%*	No.	%*	No.	%*	No.	%*
Spruce	130	51.3	56	22.2	74	29.3	28	11.0	46	18.2	10	3.9	15	5.9	51	20.2
Balsam	21	8.3	12	4.7	9	3.5	6	2.4	3	1.2	...	....	2	0.8	5	2.0
Hemlock	16	6.3	2	0.8	14	5.5	9	3.5	5	2.0	4	1.6	...	....	1	0.4
Yellow Birch	38	15.0	8	3.2	30	11.8	9	3.5	21	8.3	3	1.2	...	....	18	7.1
Soft Maple	32	12.6	4	1.6	28	11.0	15	5.9	13	5.1	5	2.0	1	0.4	9	3.5
Beech	15	5.9	2	0.8	13	5.1	11	4.3	2	0.8	1	0.4	...	....	1	0.4
Black Cherry	1	0.4	1	0.4	...	....	...	....	...	....	...	....	...	....	...	....
Totals	253	100.0	85	33.6	168	76.4	78	30.9	90	35.6	23	9.1	18	7.1	85	33.6

*Percent figures based on total number of trees per acre 4 inches DBH and over standing in the original forest.

TABLE III

Permanent Sample Plot 10 1 20
Spruce Swamp Type—Logged for all Softwood Species to a 4 *Inch DBH Limit in* 1918-1920
Area 1 *Acre*

	Trees per acre 4 inches DBH and over standing in virgin forest previous to logging operations in 1918		Less trees per acre 4 inches DBH and over removed in logging operations in period 1918-1920		Equals trees per acre 4 inches DBH and over standing on area at conclusion of logging operations in 1920		Less trees per acre 4 inches DBH and over which died and disappeared from the stand between 1920 and 1922		Equals trees per acre 4 inches DBH and over standing on area in Sept. 1922	
	No.	%*	No.	%*	No.	%*	No.	%*	No.	%*
Spruce............	267	78.0	187	54.7	80	23.4	55	16.1	25	7.3
Balsam...........	68	19.8	53	15.5	15	4.4	15	4.4	..	....
Yellow Birch.......	7	2.2	1	0.3	6	1.8	..	....	6	1.8
Totals.........	342	100.0	241	70.5	101	29.5	70	20.5	31	9.1

*Percent figures based on total number of trees per acre in original forest 4 inches DBH or more.

Some attention was directed to determine in what size classes the greater part of the mortality took place. On the first two areas, which have existed a sufficient time since the cutting as to be fairly indicative, it was found that 49% of the mortality took place in trees 9 inches DBH or less, which were left standing following the logging operation, 30% in the trees 10-15 inches DBH, 11% in the trees 16-20 inches DBH and 10% in the trees 21 inches DBH and over.

For purpose of checking on the tendencies toward deterioration after lumbering, the results from two other sample plots in cut over land are submitted. Too short a period has intervened between the cutting and the present to give them other than indicative value.

C—PERMANENT SAMPLE PLOT III

This plot was established in August 1922 in the Spruce Swamp type cutover for all softwood species to a 4 inch DBH limit in the period 1918-20. The plot is located in the town of Colton, County of St. Lawrence, N. Y., about one mile east of Barker's Point, Cranberry Lake, N. Y. The site is that of a typical spruce swamp with some standing water in the surface layers of the ground and a mucky, peaty soil overlaying hardpan beneath. Previous to the logging operations of 1918-20 no other lumbering had been done.

Of the 342 stems 4 inches DBH and over standing in the original forest, some 70% or 241 stems were removed. This is a much severer cutting than reported for the previous two sites. Of the 101 stems 4 inches DBH and over surviving the logging operations within four years from the first cutting, some 70 stems dropped out, two thirds through windfall, leaving a net survival of only 31 stems 4 inches DBH and over or 9% of the original forest. This represents an extreme annual mortality percent of 17.3.

D—PERMANENT SAMPLE PLOT IV

This plot was established in 1922 in the Mixed Hardwood type cut for softwood only to a 4 inch DBH limit in 1918-20. Previous to this logging operation no other cutting had been done. It was mainly on gentle slope to southeast, soil and moisture conditions normal. This plot was located in the town of Colton, St. Lawrence County, N. Y.

Due to the fact that only softwoods were removed in the logging operation this cut was relatively light compared with the figures submitted for the other plots. Out of some 204 stems per acre, 4 inches DBH and over in the original forest, only 73 trees or 35% of the stand was

TABLE IV

Permanent Sample Plot 10 1 21
New York State College of Forestry Series
Mixed Hardwood Type—Logged for all Softwood Species to a 4 *Inch DBH*
Limit in 1918-20
Area 1 *Acre*

	Trees per acre 4 inches DBH and over standing in virgin forest previous to logging operations in 1918		Less trees per acre 4 inches DBH and over removed in logging operations in period 1918 to 1920		Equals trees per acre 4 inches DBH and over standing on area at conclusion of logging operations in 1920		Less trees per acre 4 inches DBH and over which died and disappeared from the stand between 1920 and 1922		Equals trees per acre 4 inches DBH and over standing on area in September 1922	
	No.	%*	No.	%*	No.	%*	No.	%*	No.	%*
Spruce	98	47.9	64	31.4	34	16.7	18	8.8	16	7.8
Balsam	1	0.5	..	....	1	0.5	1	0.5	..	....
Hemlock	19	9.3	7	3.4	12	5.9	..	....	12	5.9
Yellow Birch	10	4.9	..	....	10	4.9	..	....	10	4.9
Hard Maple	14	6.9	1	0.5	13	6.4	..	....	13	6.4
Soft Maple	..	....	..	....	..	....	..	....	..	....
Beech	62	30.4	1	0.5	61	29.9	1	0.5	60	29.4
Totals	204	100.0	73	35.7	131	64.3	20	9.8	111	54.5

*Percent figures based on total number of trees per acre in original forest 4 inches DBH or more.

removed. Between 1918 and 1922 windfall and natural decay removed from the surviving stand 20 trees per acre 4 inches DBH and over, giving us an annual mortality figure of 3.8%. At the end of the growing season in 1922 there were 111 stems per acre 4 inches DBH or over on the site, or 54.3% of the original stand.

The results from these four plots are briefly summarized in the following table:

TABLE V

Summary of Mortality Data After Logging
Based on 4 Sample Plots
Area 1 Acre

	Plot No. 1 Mixed Hardwood Type Logged for Hardwood and Softwood	Plot No. 2 Spruce Flat Type Logged for Hardwood and Softwood	Plot No. 3 Spruce Swamp Type Logged for all Softwood to 4″ DBH Limit	Plot No. 4 Mixed Hardwood Type Logged for all Softwood to 4″ DBH Limit
1. No. of stems per acre, 4″ DBH and over in original stands............	183	253	342	204
2. No. of stems per acre, 4″ and over of original stand removed in logging operations.........	80	85	241	73
3. Percent removed in logging operations..............	43.8	33.6	70.5	35.7
4. No. of stems per acre, 4″ DBH and over which disappeared from the stand up to September, 1922..........	49	101	70	20
5. No. of years since logging...........	14	14	4	4
6. Average No. of stems 4″ DBH and over dropping out of stand...........	3.5	7.2	17.5	5
7. Annual mortality percent in terms of stand immediately surviving logging..	3.4	4.3	17.3	3.4

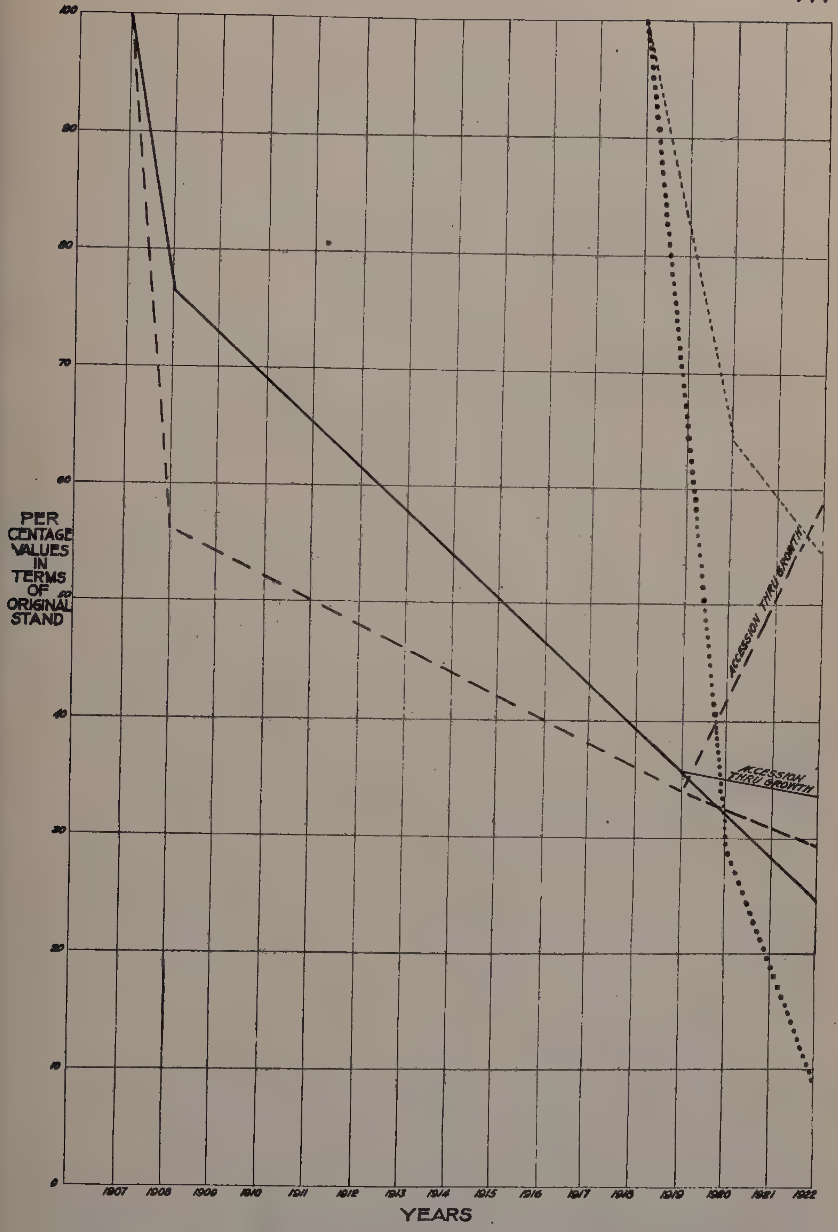

FIGURE I:- *Graphic Representation Of Mortality After Lumbering; Mixed Hardwood Type Logged For Hardwood And Softwood 1908 — — — — —: Spruce Flat Type Logged For Hardwood And Softwood 1908 ————: Spruce Swamp Type Logged For All Softwoods To 4" D.B.H. Limit ··········: Mixed Hardwood Type Logged For All Softwoods To 4" D.B.H. Limit - - - - -*

From the foregoing the following conclusions may be adduced:

1. That on cut-over areas there seems to be a surprisingly high degree of mortality in the individuals surviving the logging operation.

2. This mortality in survivors of the logging is initiated very soon after the cutting and continues for a period of from 12 to 14 years.

3. Both in its severity and in its duration, mortality is influenced directly by the intensity of the logging operation.

4. The recovery of the site seems to be centered in the growth of small sized sapling and seedling trees rather than in increased growth in the surviving members of the original stand.

5. A definite trend toward recovery can only be said to be accomplished when the growth from the substand counterbalances, at least in numbers, the continued disappearance of these survivors.

6. The results of this study are believed to be indicative rather than conclusive. A certain amount of this mortality, believed to be relatively small, would have occurred anyway through the pathological medium of natural decay in veteran trees. That this natural factor has been accentuated and hastened is without question. The only problem is the extent to which it has been aggravated. Definite figures are lacking as to the amount of natural decay in the virgin forest. A study supplementary to this might be directed toward the acquiring of such information.

7. It would appear that the growth of trees in a forest, and especially in a virgin forest, represents a delicate equilibrium between the constructive effects of the factors of the site tending to promote the continuity of the forest, and the forces natural or otherwise striving to break them down. Of all the agencies of destruction capable of upsetting this equilibrium, with the possible exception of fire, the operations of lumbering are by far the most far reaching, producing effects both immediate and sustained.

8. Nothing in the above is to be construed as meaning that the main effect of lumbering is forest devastation. The immediate effect of lumbering seems to be deterioration rather than devastation. There is not only deterioration in the numbers and condition of the stand left on the ground but also, through the almost complete removal either through cutting or death of the most desirable species, a promise of marked deterioration in the composition of the future forest. The last word in forest deterioration cannot be written, however, until the completion of a full tree generation.

9. Since the removal of as small an amount as 33% of the stand, engenders the death of at least 60% of the survivors within the first fifteen years following the lumbering operation, and where more conservative cutting cannot be practiced, it follows that as foresters we might seek fuller utilization of trees now regarded as undesirable which are left standing to die, drop and disappear through natural agencies. Approximately only 12% of the wood in such a forest reaches the ultimate consumer, 18% is wasted in slabs, edgings, sawdust, etc. and 30% drops to the ground and rots. Surely this is a fruitful field for investigation by the forest economist.

10. It would appear that mortality is less and recovery quicker and more pronounced in the Mixed Hardwood type than in either the Spruce Flat or the Spruce Swamp types.

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FACTS FIRST THEN COMMON SENSE

By P. S. Lovejoy

If a great corporation, owning some millions of acres, say, in the Lake State or Southern pineries, and with full control over its property, and with adequate funds, were to employ a group of veritable experts—foresters fairly represented—for the purpose of determining upon and then administering a long-time program of land utilization, how would the experts proceed?

First, no doubt, (since it is assumed that they are truly competent) they would recognize that their job was typically and essentially one in engineering. They would provide a seasoned engineer to be their chairman, and their chairman would quote Hoover to them, saying:

"Survey it, weigh it, measure it. Find out exactly what you are dealing with. Mark it down so anybody can understand it. Then, knowing where you are at, sit down sensibly to cooperate in taking the steps which common sense shows to be for the benefit of everybody concerned."

First, then, there would be an inventory. Then there would be specific planning for each of the several known practicabilities, with well-figured experiments to explore the possibilities.

The three major items, of course, will involve agriculture, forestry, and recreation, which will include fishing, hunting and trapping.

For each of these major items, the initial inventory must be complete enough to chart the history of past experience, show existing conditions and permit a safe anticipation of the immediate future.

The inventory will at once begin to identify three classes of land. First, the areas certainly and without question available for early agricultural use. Second, the areas where, certainly and without question, forests are the best bet in sight. Third, the areas where recreational utilization is obviously the outstanding opportunity.

The total areas to be so identified, will probably amount to but a small part of the total acreage. For most of it there will be conflicting opportunities, practicabilities and possibilities. In places grazing may conflict with hardwood reproduction. Logging may conflict with hunting and scenic values. In other places the chances for developing any form of profitable utilization may be indefinite or obviously remote.

The inventory returns having become available, the board of ex-

perts will doubtless decide to eliminate certain of the least promising acreage and will probably determine upon the purchase of neighboring acreage of desirable character or where needed to block in the holdings for administrative purposes.

Detailed planning and work in the development of the no-question farm, forest and recreation areas may start at once and while the disposition and treatment of the future—uncertain areas is pending. The protection and extensive working of these dubious areas will of course be organized as early as practicable.

Analysis and final determinations (subject of course to constant revision as new information or changed conditions warrant) will be worked out from the inventory and supplemental reports.

It will be evident enough, from the first, that the country is naturally and permanently divided into fairly homogenous units of topography, soil and cover: sandy plains, clay ridges and bottoms, broken hills and the like. For each of these units, in most cases, it will be practicable to make a simple entry to express its average quality and prospects in respect to agriculture, forestry and recreation.

"A-1, B-1, C-2," for instance, might indicate: "Certainly is farm land but now well timbered. Chances for wild-life and present stocking medium only."

Or, "A-3, B-2, C-1," might indicate: "This is out of the question for agriculture, medium only as a permanent forest proposition, but certainly is full of game."

It would, of course, be desirable to extend the degree of classification and description far beyond such a crude system, but the results, in any case, would boil down to specific ratings for each land unit, and would read in terms of present and future value for each of the several forms of utilization. The rest would be detail and explanation.

Financial and other considerations, such as the local markets for farm and forest products, would affect the rate at which developments were scheduled.

In the settlement work, no doubt, the most modern practices as worked out in Wisconsin, California and Canada would be utilized and settlers would be hand-picked on the basis of their experience, temperament, family and cash. They would be located on well-planned farm units and under an equitable contract. They would be provided with highly competent advice and assistance.

The interlocking relations of the farm development with forest and recreational affairs would be well considered, in advance, and so as to provide an outlet for surplus farm labor.

In the conduct of the forest work, the first item will be to give good fire protection and, next, to scale down or prevent the progressive devastation of mature stands now being cut. While much planting work may be necessary, rather inferior second-growth, if natural, will be considered satisfactory, for the present. Salvage of current wastes, in woods, at mill and in the markets will receive much study and the Madison laboratory will be a not-too-silent partner. Experiences at Cloquet and Bogalusa will be used to the full.

The experts in charge of recreational and wild-life affairs will have few and poor precedents. They will, of course, have identified and named each typical habitat and range and will have something of a census of the wild-life associated with each. They will have adopted some manner of approximating the current carrying capacity of each habitat and range (in terms of deer, grouse, turkey, beaver, etc.) and also some manner of indicating the current degree of stocking.

Presently they will be considering ways and means for running up both carrying capacity and stocking to or towards a theoretical maximum, exactly as in the case of the grazing administration on the National Forests. The technique for doing this, and for locating and dealing with the limiting factors, must be developed as the job progresses for it is at present almost utterly lacking or unknown.

The experts in charge will, of course, figure on greatly exceeding the usual or natural yields per acre and per year, and on the farms, forests and game ranges will look to see a steady increase in turn-off which will continue indefinitely and without sacrifice of basic capital: soil fertility, growing stock or breeder stock.

All this is wholly practicable, no doubt. In fractional parts and one place or another, it is being done. Musk-rat, beaver and frog farms are in operation. Fish fry come by the can as pine seedlings come by the thousand. Deliberate and complex settlement operations are the only ones which now offer any real hope of success. That forest operations must be deliberate and well planned is a professional axiom.

And yet the whole thing is a mere fantasy. The Biltmores come and go. Cloquet and Bogalusa advertise. The Experiment Stations, forest and other, fuss and flutter.

Meanwhile tens and hundreds of millions of acres of once-productive land, burn again, are culled again, are slashed some more and drift or skid to or into idleness and bankruptcy.

And meanwhile foresters repeat their litany of "Fire, Taxes and Devastation," and squabble over the handle to the tool.

The agronomists recite their litany of "Lime, Alfalfa, Blooded Sires."

The U. S. Geological Survey indicates forest cover with a single tone of green ink but the U. S. Soil Survey does not indicate forest cover at all, and the Geological Survey does not indicate soils. Forester's maps show topography and forest cover in great detail but do not know soils. The Isaac Walton League incoporates fire control among its main objectives but no forest experiment station lists a single item relating forests and wild-life. The only specific wild-life experiment station in the country lacks for funds.

So things ripen, and, I think, to the point where, presently, a new conception and procedure will appear and begin to function.

This is the conception that, from now on, land utilizations must be engineered.

In an abstract and academic form, the idea has already been formulated. Having been heralded, gingerly, in previous volumes, it is now boldly announced, and as the result of general and mature departmental deliberations, thus:

"The conclusion (that a lot of stump land is idle and not soon, if ever, to be used in agriculture, etc.) implies that the areas that are to be devoted to reforestation, as well as the areas that should be reserved during the next forest cycle for pasture and crops, should be determined by deliberate selection. To this end it has for some time been recognized that a systematic classification of our reserve land area is requisite." (Yearbook, U. S. Dept. Agriculture, 1923, 502.)

There, plainly enough implied, though not stated, is the notion that from now on, land utilizations must be scheduled on the basis of adequate information and with each style of land utilization considered and planned in advance and with due relation to all other, or competing, utilizations. That is, the job must be engineered.

A "classification" of lands is the first "requisite" for such a job. Unless to be actually used, and used intelligently and deliberately, no mere inventory or classification would be worth attempting. It is the final application of the data given by inventory or classification which

counts. But the mode and manner in which such base data is to be used, the mechanism of the new-style land development, the precise *modus operandi,* is unspecified, unexplored—in fact unknown to the departmental deponents.

It is, indeed, unknown to everybody; almost wholly to be prospected.

Precedents are almost wholly lacking. The scale upon which the coming operations must work invalidates what little precedent has developed from private experience.

Such as it is, the only real precedent is to be found in the administration of the National Forests and is written in the Manual. There, in limited form, agricultural, recreational and forest affairs are blended harmoniously and under a single objective: wise use of land.

Somehow, and soon, we must devise a method of procedure which will engineer a wholesale land utilization in the cut-over regions of the East, North and South, and with private, county, state and federal agencies all involved.

The Clarke-McNary Act may prove a starting point even though it spans but a short segment of the necessary arc.

The formula is the parallel and harmonious development of farms, forests and recreational resources.

In that job there are evidently two major phases: first inventory work, then the engineering of land utilizations upon the basis of the inventory.

For the technique of intensive inventory work there is now most excellent precedent in the work of the Michigan Land-Economic Survey.

In very full detail, soils, cover and utilization (past and present) and economic status are reported and graphed.

When the planimeter is run over the maps, township by township and county by county, it is highly evident whether the farming of Coloma sand has proven practicable and whether forests have any business on the level phases of Antrim loam.

In township 61-9, for instance, 85 percent of the Superior clay is in farms but of the Silcon soils, a scant 10 percent. But the record shows that, 30 years ago, the percentages were reversed. The assessor's present valuations check out with the soil and cover maps. The planimeter analysis shows the acreage of dense, medium and scant forest growth, for three types of pine, three of hardwood, and for three of swamp, and for the fire-weed stands such as popple, jackpine, etc., and,

for each, the acreage in average diameters running from 3 to 12 inches and up.

This symbol means: "Typical high-grade timber swamp with cedar excellent, cut-over but not burned, dense stand of young stuff mostly under 6 inches diameter." Another symbol says: "Cassandra bog with deep peat—no marl." And so on through two dozen and more types and classifications which permit indefinite combination to express almost every possible, and every important combination, from the acreage in potatoes to the patches of pasture too rocky to plow and abandoned houses; from virgin timber to utter devastation: soil, past and present cover, past and present utilization and economic status, all on the maps and to be taken off and tabulated as wanted.

Toward three million acres (3,000,000) of that has been done and at a cost for field work well under 5 cents an acre.

That part of The Job, then, is well prospected. The complete practicability of taking inventory of agricultural, forest and recreational resources, at very reasonable cost, is proven. It is being done and on a scale to satisfy any questions. It is being done for a few cents an acre.

But perhaps, even so, it may cost too much to insure similar precision and accuracy in making inventory of great acreages of very low-grade land. In some regions and states, any attempt at precision may, for the present, be out of question.

But, wherever there is a land problem, especially an idle-land problem, some manner of inventory is "requisite."

It may be had without the special staff and fund under which the Michigan Survey has operated. Thus, perhaps:

Let the Director of Extension at the Agricultural College, secure standard county base maps, on a scale of an inch per mile, say. (In Michigan the State Highway Department has and provides such maps).

Let the Director send out these maps, in blank, to his county agricultural agents, together with a set of simple instructions calling for the mapping of the dominant soil types (where no soil surveys have yet been made). The classifications may well be broad, at first, but can at least approximate the boundaries of the soils known to be suitable for agriculture, those more or less dubious, and those very dubious.

For his own local use, if for no other purpose, the county agent (and the College) should have this information, and, in addition, much supplemental data, as to the areas and acreages under actual cultivation, and to which crops, etc., etc.

A few days work in the courthouse, as by the county agent's clerk, would compile another map showing the assessed value of all the lands in the county, as by classes: Under $5 an acre, $5-10, $10-25, $25 up. With this, the judgments of local people as to actual and relative land values, is easily available, and invaluable in reporting upon or estimating utilizations.

While the county agents are reporting upon the major soil divisions, a similar set of maps may go out through the appropriate offices, to the State Fire Wardens and to the Game Wardens.

The Fire Wardens will be supplied with a simple set of mapping instructions and colored pencils and, preferably, a sample map, and will be expected to report on cover and factors affecting fire hazards and control work.

If they map in virgin stands of pine, hardwood and swamp timber, open plains, slash areas, camp locations, and at least block out the larger areas cleared or in cultivation, and indicate the character of second-growth areas, the major features of the whole situation will be quite plain.

The Game Wardens, in turn, can indicate the areas known to contain specified wild-life in dense, medium or scant populations and, when fitted together, the status of deer, partridge, turkey, beaver, trout and what-not, will be well shown by the maps, no matter how crude.

The advantages in having such map work done by the field men who must, of necessity, cover nearly all of nearly every state, should be obvious. If they already really know their districts they can draw them in with little effort, or the information can be coached out. If they do not know their districts, the necessity for mapping them will force some travel and needed observation. The enormous administrative losses due to failure in getting written records of local experience, and the continual turn-over in personnel, should be obvious and in itself enough to justify such work. That so little such work has been done or attempted by any of these agencies, needs little comment.

It would be necessary, of course, for someone to stimulate and then coordinate and compile the records, and to provide means for annual supplements, corrections and additions, as in the handling of the National Forest Atlas. That should not be difficult to manage once a real and state-wide effort at inventory is under way.

An inventory and classification of lands, then, is requisite and now

available: in Michigan, tested and proven and for both intensive and extensive forms.

But what of the mechanism for getting such base data soberly digested and then acted upon?

"How are you going to use the inventory?"

As asked, the question usually seems to imply a right to some definite committment as to administrative organization, perhaps as suggested for the hypothetical corporation. But that, I think, is hardly the case.

To analyze the situation and perceive and announce the nature of the solution was a problem for students. To devise, contrive and prove the practicability of the essential device was a technical problem. To devise and contrive the machinery for the accomplishment of The Job itself will prove, no doubt, a problem in politics.

As the technical problem may appear difficult to the academic mind, so, perhaps, the technical mind is helpless in confronting a political problem. In any case I cannot anticipate any real difficulties in translating a truly competent land inventory into specific and reasonably competent action. The thing will have momentum behind it.

The most persistent of old-line boomers, when they come away from their first inspection and demonstration of the Michigan Survey maps, are no longer belligerent. The case is too plain: painfully plain, perhaps, but beyond all argument. . . . .

Farms? Why sure! This map. Cultivated lands are blank. See? Now this map. Soils. See how the farms bunch into certain soils and straggle or fail in others? No accident. Used to be a big settlement in these yellow townships. Now this chart. See the population curve go down since 1890? See assessed valuation go down? No accident about it. Same thing wherever we find Rubicon and Coloma. See those little crosses? Abondoned places. Want to see photographs of some of 'em? Well, look at this map, now. Lands advertised for 3-year old taxes. Want to see the lists in the county paper? Sure, quite a lot. More in other counties, though. Only 17 percent of this one up for taxes just now.

See any real chance for extending agriculture in those yellow areas?

Well, then, how about this? Timber or nothing. Timber and game, that is; game and tourist traffic.

Fact. Nothing but scrub oak and popple and jackpine in there now. Was good white and Norway. Not even seed trees, now. Fires

did it. Yes, planting costs money. Oh, about $10 an acre. Plenty of waiting, too. Yep.

But did you know that even the scrub oak makes some railroad ties—give it time and keep out fires? Oh, yes: perfectly certain. Want to see the tallies and volume tables? And a lot of pulp wood could come out of the popple and Jack. What's half a cord a year off three full townships? How many carloads? What in wages?

Well suppose you don't get it. You do get deer fodder. Got any idea what those oaks turn loose in the way of feed for deer and partridge? Know what it costs the average city sport to get a deer? Know how many deer were shipped out of there last fall?

Room and feed for a lot more, too. Three or four times as many, we estimate. Trouble is winter shelter for 'em. Need a good cedar swamp within reasonable distance. See the purple on that map? Fine swamp. Deer bunch in there, winters. Partridge too. Ought to be a permanent refuge and game preserve. Worth more for that than for the posts and pulp. Key to stocking all this yellow country with game. Cut and burn the swamp—then mighty little game in the yellow.

No funds. Oh they couldn't think of buying 'em all up. Why this one and not the rest? If you people in there are interested, why not see about getting the owners together and trying it? County might do it on its own hook. Why not? Be worse broke, directly, won't it?

But you could expect help with fire lines and planting, in there.

Take a lot of work to do it and keep it up. Local people, of course; teams and so forth. Every year, of course. And by and by the pine and the rest of it would start coming out and you'd have new mills and the like. Not so big but permanent, this time. Regular crop, you see.

But nothing like that unless the Legislature says so. It won't say so unless you folks up there come in yelling for it. Probably have to make a proposition and take about so much of it on your own hook.

State could probably get the federal government in to take a big piece of it too. Oh sure. Clarke-McNary Act. Yes, yes. Might be right in there where you are. Why not?

Anyway do you see anything else in sight?

Well, when you local people up there get it figured to suit you, and send somebody down yelling for it, and bring in the neighbors, it will happen. You know mighty well it will. But nobody is going to bring you anything on a plate.

Yep, copies of these maps and things as soon as we can get money to print 'em. Yep, got your name on the list.......................

What, more than anything else, has prevented a rapid advance in forest affairs? Certainly it is that local interests have not demanded it. As almost always proposed, "forestry" has been something expensive and to be imposed, by outsiders, upon unwilling local communities.

If the essential ideas can be "sold" to the local communities, and so as to set them to demanding specific help and outside assistance (as in the case of roads and schools), then, I think, we shall move with unprecedented directness and despatch.

And what is most apt to stimulate local interests so as to set them to asking and demanding and insisting upon State and National forests, fire-lines and towers, game protection and the rest?

Two things at least: First, the perception that there will be local profit in it; second, the fear of consequences if they do not.

A proper inventory, properly "sold," I think, will work both ways.

There are Michigan counties without a single standard school. There are Michigan counties which have received a quarter-million dollars more, of State money, for roads and schools alone, than the sum of all the county money sent to the State Treasury. There are counties where the tax rate is now 5 percent—and upon a full valuation. Counties where a quarter of all the land is being advertised for taxes.

In all this Michigan is not alone: merely a little more experienced and battered, perhaps; a little more willing and able to get and face the facts; the essential facts upon which parallel and harmonious programs for the development of agricultural, forest and recreational resources, may and must be based.

MANUAL LABOR SAVING DEVICES IN NURSERY PRACTICE

By William F. Dague

District Forester, Pennsylvania Department of Forests and Waters

At the time the Clearfield Nursery, located in Central Pennsylvania, was established in 1910, and up until 1915, manual labor could be had at from 8 cents to 15 cents per hour. Today the same kind of labor is hard to obtain at from 35 to 50 cents per hour. Forest tree seed which now costs \$2.00 to \$20.00 per pound, could be purchased (1910 to 1915) for less than one-fourth the present prices. Prior to 1915, 2-year old seedlings seldom cost more than \$1.00 per thousand at the nursery. During the last few years it has not been uncommon to pay more for an amount of seed sufficient to produce a thousand seedlings than the entire cost of raising a thousand 2-year old seedlings from 1910 to 1916.

Many of the forest tree seedling nurseries in this country have been closely following European practices. Manual labor in Europe has always been very cheap, and consequently nursery work was largely done by hand labor. The first tree nurseries in this country which were largely patterned after European nurseries, adopted hand labor methods of nursery production. The scarcity and high price demanded by labor during the last 8 years has necessitated a change, and labor saving devices and implements have been substituted for much of the hand labor.

In the Clearfield forest tree nursery we have adopted, with, and in some cases without, any changes, many agricultural implements in order to lessen the manual labor and cheapen the cost of raising the seedlings and transplants. In preparing the beds for seeding which, in the early years of nursery work was largely done by manual labor, is now almost entirely done with horse labor. The nursery is plowed, harrowed, and rolled just as would be done for an ordinary agricultural crop. The seed bed is then thrown up and the path made by a double plow, an implement a local blacksmith made by welding together two plows, one with a right-hand and the other with a left-hand mould board. The handles were rearranged so that the plow could be guided by a man walking in the path. The beds are then harrowed and finally leveled with an ordinary split log drag. The beds are now ready for seeding. Before seeding the lines are drawn. The stakes for the

lines being spaced for the beds a distance apart equal to the width of the bed plus that of the path. Then an open frame, made in the form of a rectangle having the exact width of the beds (4 feet) and a length of 12 feet, is placed on the bed, with one side adjacent to the line. This frame is made of lath 1 inch thick and two inches wide, nailed so as to form an open frame two inches high, 12 feet long and 4 feet wide. Cross laths six feet in length are nailed about one-third distance from each end across the width of the frame to act as handles in moving the frame back and forth. The principle is the same as seeding a boarded bed. When the area within the frame is seeded the frame is moved forward to the next bed. In this way two men can usually sow from 100 to 300 pounds of seed in 8 hours, and there is no trouble in making a uniform sowing and keeping the row of beds in a perfectly straight line.

In many nursery beds the seedlings occupying the central portion of the bed do not develop as well, neither in root nor crown, due to crowding, as do the seedlings that occupy the area along the edges of the bed. In order to remedy this feature and produce more uniform and better developed seedlings, two narrow strips, one on each side, 6 inches wide, extending the length of the bed and a foot from the edge, are left vacant. In seeding these beds a similar seeding frame to the one used in seeding full beds is employed. The frame having additional strips extending the length of the frame forming three one-foot wide partitions, one along each side of the frame, and one in the middle. These partitions represent the seeded portion of the bed.

After the seed is sown the beds are firmed by a four-foot wooden roller four feet in diameter, weighing three hundred pounds. The roller is made of white pine plank. It is easier and many times cheaper to operate than the board method of firming the soil. This roller is also preferable to the ordinary concrete and iron lawn rollers which are usually heavy and compact. Their small diameter makes them hard to handle in loose soil. In rolling loose soil the compact rollers made of concrete force the ground and seed forward which makes this class of roller undesirable for nursery work.

The paths, which were cleaned by the use of an ordinary garden hoe during the first years the nursery was operated, are now cultivated with a one horse cultivator. This is a far cheaper and better method. The heavy rains which formerly ran off of the hard paths and occasioned washouts, now are absorbed and utilized by the tree roots.

The weeding of the nursery, which is a big item of expense in seedling production, is still done by laborers, but it is expected in the near future to rid the nursery of weeds by steam sterilization, similar to the manner in which the tobacco plant beds in the tobacco area of this state are kept free from weeds by steam sterilization.

The hardwood seedlings in the Clearfield Nursery are raised in rows 10 to 15 inches apart and are cultivated by a gasoline motor cultivator. Far superior and cheaper seedlings can be raised in this manner by row seedling than can be raised by the broadcast method. If the seedlings are raised in rows, very little hand labor is required and the soil is kept loose and the rains easily filter into the soil, while in broadcast sowing all the labor is manual labor. The soil becomes harder and usually the rains run off before entering the soil.

The transplanting in the Clearfield Nursery is done by the "Nisco Planter," an implement similar to the tobacco planter, which is used extensively in Lancaster County, Pennsylvania. It requires three men to operate and the power to draw the implement requires two horses. There is an attachment for fertilizing and watering the plants at the time of planting. Ordinarily three men can plant more seedlings with this implement than twenty men can accomplish by hand.

All the hardwood seedlings, transplants, and ornamental stock of the Clearfield Nursery are lifted by the "Ornarga shrub lifter." The operation usually requires one man to handle the team and one man to handle the implement. Two men with this implement can lift more trees than can 25 men with the ordinary hand implements, and seedlings and transplants are lifted with far less injury than by the ordinary hand methods. Some work was done on a seedling lifter for lifting the coniferous seedlings which are sown broadcast. This implement is not yet perfected. If several changes are made it will be serviceable. The writer feels that the operation of this lifter will bring about a great saving in nursery labor expense.

The manual labor saving devices can already be credited with saving much money in the Clearfield Forest Tree Nursery, and the writer believes that by a little study and experimentation, additional devices can be invented and improved that will effect substantial economies.

VALUATION OF FOREST PROPERTY IN WRITING INSURANCE

TRANSLATED BY G. W. HULT

In valuation of growing forests the following valuation methods are recommended for use:

1. Cost-value-method;
2. Expectation-value-method;
3. Sale-value-method.

Which one of these methods to be used, in each separate case, depends on the degree of development of the stand.

As a rule, it is customary to use the cost-value-method in valuation of stands grown either by artificial or natural means, which have not yet attained such an age or such appearance, that the value of the final cut can reasonably be fixed or predicted with certainty. If the stands have attained such an age and such a stage of development that the future income can be fixed, the expectation-value-method is used.

Both cost and expectation-value-methods are used in the valuation of such growing stands, which from a forestry standpoint, can not yet be cut and sold to advantage (young and middle-aged forests).

The rate of interest in these valuation methods is 3 per cent.

In calculating according to the cost-value-method, tables are used showing the amount of interest on the land according to the land value per hectare, for each 5 year age class from 5 to 60 years.

Another table gives the silvicultural costs per hectare for each five year class.

A third table gives the final interest value of the cost of administration per year an hectare for the same age class.

Values for other age classes can be proportionally figured by analyzing the values in the tables.

The land value is calculated theoretically according to the formula:

$$\frac{Au + Da \times \mathrm{I,\ op}^{u-a} + Db \times \mathrm{I,\ op}^{u-b} - C \times \mathrm{I,\ op}^{u} - V}{\mathrm{I,\ op}^{u} - \mathrm{I}}$$

In this formula

Au is the income from the final cutting in year u.

Da is the income from thinnings in year a.

Omsesidiga Forsakringsanstalten *Sampo*, Abo, Finland.

Anvisningar rorande vardering av skog vid tecknande av forsakring samt vid skadeuppgorelse.

Db is the income from thinnings in year b.
C silvicultural costs.

V O $\frac{v}{}$, op where v = yearly administration costs.
P = per cent.

2. *Valuation According to the Expectation Value Method*

The expectation-value of an m aged stand is calculated according to the familiar principle that all income, both in the form of thinning as well as the main income at the age u, at which time the cutting is assumed to be advantageous, is discounted to the present age m, after which the resulting amount is reduced by the current costs of production during the time u - m discounted to the point m. Example: It is desired to determine the value of a 50 year old stand according to this method. It is considered that the stand at 80 years will yield $800 per hectare for the cut, at the age of 60 years thinnings amount to $100 per hectare, and at 70 years $180.

The land-value is $50 per hectare, the yearly cost of administration is $0.50 per hectare and the rate of interest is 3 per cent.

CALCULATION

Amount for the cut at 80 years	$800 :-
Income from thinnings at 60 years $100	
Compounded for a period of 20 years 3%	180 :-
Income from thinnings at 70 years $100	
Compounded for a period of 19 years at 3%	241 :92
	$1,221 :92

This sum $1,221 :92 is discounted up to the 50th year of the stand or at 80-50 years, which will then amount to..................$502 :20
In the amount $502 :20 is included:
The yearly expenses during 30 years, namely interest on the land-value $50 at 3% ....$1 :50
Yearly administration costs .... 0 :50

Yearly expenses..........$ 2 :-

This yearly interest, which is paid up to the 80th year of the stand, discounted to the stands present age 50 years has a capital value of 2 19.60 $39.20. Subtracting $39.20 from $502.20 the result will be the value of the 50 year old stand, or $463 per hectare.

As valuation according to this method presupposes the use of factors—future amounts of the cut—which can only be determined from experience, only competent professionals can make use of this method.

3. *Valuation According to Sale-Value-Method*

A forest ripe for cutting is valued according to this method, when in one way or another the amount of lumber and by-products is estimated, which are then priced according to local going prices.

When a forest is reported for fire insurance, the value of the forest should be given as near to the facts as possible. A too high valuation of the forest results only in unnecessarily high premiums for the policy holder, because in case of fire damage the actual value of the forest is taken as a basis for arriving at the damage.

If the insured forest is valued too low at the time of insuring, the consequence is, that in case of fire damage, indemnity is paid only in the proportion, in which the amount of insurance stands to the insurance value.

VALUATION OF FIRE DAMAGE

In case of fire the fire damage must be appraised:

1. When the entire burned area is appraised according to its condition before the fire.

2. The value of all that is saved from the fire is determined (both damaged and none damaged trees within the complex, which can be utilized).

3. The difference between these two values before and after the fire is the amount of the damage.

Example: Fire has occurred in an insured forest complex.

The value of the complex before the fire was................	$20,000
After the fire	10,000
The damage is therefore	$10,000

As insurance is written up to only ¾ of the value of the forest, in this case $15,000, the insurer receives as indemnity 75 per cent of the amount of damage, or $7,500.

Had the above forest complex been insured for a lower amount than the actual value, for example, $18,000—in which case the amount would have been 75 per cent of $18,000 or $13,500, the indemnity in this case would not have been $7,500, but only $6,750.

Again if the complex had been insured for a higher amount than the actual value, let us say for $30,000 and the amount of insurance therefore amounted to $22,500—only the actual amount of damage, $7,500 would have been paid.

The principles for the valuation of a forest in settlement for damages are of course the same as in all other forest valuation, and the described methods of valuations will be used as they are *needed*.

GROWTH OF THE "GRAYLING PINE"

By A. E. Wackerman

Lake States Forest Experiment Station

Last fall the writer made an examination of one of the two only remaining tracts of virgin white pine timber in the Lower Peninsula of Michigan. At Interlochen State Park there is a stand of old, rather open white pine, covering about 200 acres, which is maintained as a specimen of the former forest. The other stand, known as the "Grayling Pine," lies near the town of Grayling in the north-central part of the Lower Peninsula and is a dense, young-mature stand of white and Norway pine with some scattered hemlock. It is owned by a local lumberman, is only 76 acres in extent, and is cut into to provide special stock for the mill in Grayling. As a consequence it is usually reduced in area each year. The Grayling Pine was the stand examined.

The examination was in the nature of a current growth study to determine the rate of growth of virgin stands as they grew in this part of Michigan. The timber was purchased by its present owner 40 years ago when it was unmerchantable with a view of rising stumpage prices and closer utilization. The area of young timber was in a long, rather narrow, strip surrounded by old, mature pine and probably developed from reproduction after a storm 166 years ago, the age of the stand. Scattered throughout the stand are old veteran white pines which are much larger than the rest of the trees and are presumed to be relics of the previous storm-destroyed stand. The present area of 76 acres is all that remains of any of the pine which formerly dominated the region.

White pine comprises most of the stand but there is a considerable amount of Norway pine in mixture and also some hemlock where the stand borders on better land. Surrounding this stand lie endless expanses of the Michigan barrens or "skiberions" as they are locally known. The soil of these barrens is pratically pure, dry, sterile sand, but the same soil beneath the pine is overlaid by several inches of humus and duff and is moist at all times. The soil of the sandy skiberions formerly supported extensive areas of white and Norway pine similar to the Grayling Pine, as the many stumps will bear witness.

The trees range in diameter from 10 to 24 inches and in height from 90 to 125 feet, but the old veterans have diameters up to 36 inches and heights up to 160 feet. The total stand on the 76 acres

is now 2,589,000 board feet composed of 1,691,000 feet of white pine and 898,000 feet of Norway pine and hemlock. This is an average stand of 34,000 feet per acre of all species.

Increment borings indicate that 40 years ago when the timber was acquired by its present owner there was a total volume of 1,700,600 feet on these 76 acres or an average stand per acre of 22,400 feet which was unmerchantable in 1883 on account of the relatively small sizes of the trees. The total increase in board feet volume was 888,400 feet or an increment of 11,689 feet per acre which is a mean annual increment for the past 40 years of 292 feet. This is an increase in board foot volume of 52 per cent of the volume 40 years ago and this growth is that of a dense, virgin stand and is slow; the average increase in d.b.h. for the 40 years being 3 inches for the white pine and 2 inches for the Norway pine and hemlock.

The value 40 years ago was $2.50 per acre for the land—the timber being considered valueless. Now since it is only 6 miles from the mill with a railroad spur through it the timber is valued at about $30.00 a thousand and the land is considered worthless. The present value, then, is $1,020 for the average acre which is an increase of 408 times its original price.

The increase in volume is due to growth alone, the increase in value is due to growth as well as to rising stumpage values and closer utilization. This Grayling Pine is famous in Michigan and valuable not only for its intrinsic worth but also as a picture of that great, vanished resource which gave Michigan its statehood. Some means should be devised for preserving it as an historical relic.

MINE TIMBERS

By A. D. Read

Each evening long lines of mine cars loaded with planks, timbers and stulls are collected around the collar of the shaft waiting to be lowered by the night shift. It is not at all hard to imagine the mine as an insatiable monster, with the shaft as its mouth, greedily devouring the lumber. Night after night, month in and month out, whole forests are thrown down its maw in a vain effort to satisfy the demands of the dragon but, belching hot and fetid gasses, the slimy monster calls for more and more.

Data concerning mine timbers are practically nil. A leaflet of the Forest Service written in 1905 by R. S. Kellogg gives a rough estimate of the round and sawed timbers used in the U. S. for all classes of mines, per annum, as two and one half billion feet. No doubt the present annual consumption is much greater. The copper mine at which I am now working is one of the larger ones of the West, employing 1,000 men or more. The chief engineer told me that their annual consumption of timber averages 4,000,000 feet. Multiply this by all the other mines, both large and small, in the country and it can readily be seen that mine timbers play a most important part in the lumber industry.

This 4,000,000 feet is all sawed timber—Oregon pine (Pseudostuga taxifolia)—except for an infinitesimal amount of split lagging and one or two per cent of stulls (round timbers) both of which are of white fir (Libocedrus decurrens). The Oregon pine comes from Washington and the cedar from central California. Until recently the Company bought their stulls from the South, "swamp pine" according to the engineer—Pinus palustris probably. Pinus ponderosa from both northern Arizona and New Mexico have been tried but did not give satisfaction. It was too brash.

The purpose of timbering is to prevent the ground from caving in, or in mining parlance, to "catch up the back." Whenever the workings are in good ground—solid rock—timber is not necessary.

In a copper mine, and I believe that this holds good for all metal mines, there are three principal classes of underground workings each of which has its own style of timbering. These workings are (1) crosscuts or drifts, comparable to tunnels, which are used chiefly for means of

transportation between different bodies of ore which when reached are removed bodily by stoping. This process leaves large cavern-like rooms called (2) stopes. Connecting the different levels, in addition to the main shaft, are perpendicular or inclined (3) raises—small well-like bores used either for air, water, man ways or for ore chutes.

These workings are usually of uniform dimensions in which, in each class, standard sets of timbers can be used—a set being one complete unit of the necessary timbers. Being of standard dimensions the timbers can be framed—horns, notches and bevels sawed so that the timbers will lock into place—on the surface in large quantities and sent into "the hole" as needed. The size of the timbers vary according to their class from 4″ by 6″ to 12″ by 14″ and 5′ to 18′ in length.

Crosscuts are timbered with tunnel sets which consist of two posts, a cap, two collar braces and sufficient lagging. The posts are set, with a certain amount of batter, on each side of the crosscut. On them, across the drift, is placed the cap while the lagging is put on the sides and top to prevent the rock from falling in. If there is much space between the lagging and wall (or back) "gob"—waste rock—is thrown in. Pillars of blocks or short stulls reach from the lagging on top to the back which may be fifteen inches to several feet higher according to how the ground broke when blasted. These blocks and stulls in turn are made tight and solid by means of wedges driven between them and the rock wall. The ends of the cap are also blocked in and wedged. The collar braces connect the sets, running from post to post at the top parallel with the crosscut. Their purpose is to prevent the posts from falling back during blasts for it is often necessary to timber to the face, as the end of the drift is called, where the drilling and blasting is done. Because of this the entire set must be well wedged and braced. Each set timbers five linear feet of crosscut the posts being set five feet apart in a lineal direction.

Stopes are timbered with square sets which rise perpendicularly set on set. The open space of the stope, often covering many square feet, is dotted with seven foot posts placed in five foot squares connected at their tops with caps and ties. The tops are lagged over with three inch lagging. After enough ore has been removed to make sufficient room, another set is erected on top of the lagging and so on indefinitely until a height of six to fourteen sets or more is reached. After the stope is two or three sets high it is usually gobbed in, that is, the excavation is filled with waste rock taken from other parts of the

mine. Gobbing is a means of disposal of the waste rock without hoisting it to the surface and also strengthens the old workings by preventing cave-ins after they have been abandoned. Finally when the stope is worked out, by which time it possibly reaches from one level to the next, (one hundred feet) it is all filled in with waste rock threaded with the abandoned timbers. This system of stoping is called the "cut and fill" method. Containing so much timber, usually dry, timbered stopes are great fire hazards necessitating great vigilance on the part of the fire bugs. Many stopes, being in solid rock, are not timbered.

When it is necessary to timber raises they are divided into two or three compartments. Square sets are used for the larger raises and cribbing for the smaller ones. The cribbing is four or five inch planks so cut and notched as to form a non-collapsible rectangle, five by ten feet, which is made solid by the inevitable blocks and wedges.

Where conditions do not permit the use of standard sets the timberman or miner must cut and fit the timbers into posts, caps and stringers to suit the need, underground. The workmanship and skill with which an expert can cut, fit and wedge securely into place timbers of various sizes usually with no other tools but a dull axe and a rusty saw is beautiful to behold.

Following is the name and description of the principal timbers used in metal mining. With some exceptions the same names are used for timbers in coal mining.

Tunnel Sets:

Cap—A timber 10″ by 10″ and 5′4″ or 5′6″ long to connect two posts.

Post—A timber 8″ by 8″ or 10″ by 10″ and 7′2″, 8′6″ or 9′6″ long.

Collar brace—A 4″ by 6″ by 4′2″ used as a brace between posts.

Lagging—There are two kinds (1) split or gob lagging which are two to three inch stakes 5′ long; (2) sawed lagging which are two, three or four inch planks 5′ long. Lagging is used for roofing and siding.

In the hole a "dry laggin' " typifies all that can be desired in the way of comfort. At lunch time or whenever the miner "takes five" the five foot plank, ten or twelve inches wide, thrown across the track keeps him well out of the muck and slop of the drift.

Square Sets:

Post—A 10″ by 10″ by 7′4″ timber. Four of them are used in one set, placed in the form of a five foot square.

Cap—10″ by 10″ by 5′4″. Two in a set.

Tie—An 8″ by 10″, sometimes 5″ by 8″. Two in a set. Very similar to a cap but framed slightly different. The caps and ties rest on top of the posts. The set is roofed over with a few lagging.

Miscellaneous:

Cribbing—4″ by 10″ planks or 5″ by 8″ timbers 5′ to 15′ long as it is a two or three compartment raise. A standard compartment is five feet square. Partition cribbing is 5′ in length.

Angle brace—6″ by 6″ to 10″ by 10″ about 4′6″ long used as a brace between cap and post in a modified tunnel set.

Blocks—Used in conjunction with wedges in tightening timbers. Anything can be used as a block but the standard as sawed on the surface and sent into the hole are 10″ by 10″ by 10″ and 10″ by 10″ by 2″.

Head block—A short plank 4″ by 12″ by 20″ used between post and stringer.

Boom—Any small sized timber can be used as a boom. If framed for that purpose they are usually 5″ by 8″ by 11′. They are used for emergency timbering in bad ground. Being run out from the top of the last set the cap and lagging for the next set is laid on them. Under them the miner can work in comparative safety while setting the posts.

Scab—Any piece of board or plank can be used as a scab. A scab is used anywhere to prevent a brace or board from slipping down. It is largely used in temporary work such as staging.

Spile—A 4″ by 6″ by 8′ timber sharpened at one end. Used in bad ground for quick timbering to protect the miner while drilling or while the permanent timbers are being erected.

Sprag—An indefinite nomenclature. Usually a small timber—a 6″ by 6″ or 8″ by 8″—wedged across a raise or drift to support a temporary staging or to which ventilator pipe can be attached. Again, it is the brace from the side of the drift across the ditch or gutter to the ditch lining alongside the track. (Sprags used in coal mines for braking cars are entirely different.)

Stringer—Any unframed timber usually of the larger dimensions and length.

Stull—(1) A round unframed timber about 12″ in diameter and 8′ to 12′ long. Not used much in metal mining. (2) An indefinite piece of squared timber of almost any size and length. Its use de-

termines its name as stull—an upright timber put in wherever needed. Generally used to catch or "stull" up bad ground. "All you need is something to steady it."

Wedge—Perhaps the most important as well as the smallest of all mine timbers. A 2″ by 4″ block 16″ long sawed diagonally makes two wedges. Their use is to tighten and wedge in the timbers in order to hold them in place. Nails or spikes are seldom used in timbering.

In addition to the timbers named above there is much other stuff used in a mine; ore chutes requiring timbers and planks cut to a standard measure, hundreds of running feet of ladders, guides for the cages, track ties, even the small powder sticks, 6′ and 7′ long and 1¼″ in diameter, apparently of little consequence, foot up in the aggregate to a considerable total.

SCIENTIFIC RESEARCH TO AID REDWOOD REFORESTATION

By John C. Merriam,

President of the Carnegie Institution of Washington, D. C., and President of the Save the Redwoods League

At the annual meeting of the Council of the Save the Redwoods League held on September 6th, a resolution was passed appointing a special committee and appropriating a sum of money for the carrying on of scientific research which it is believed will throw considerable light on the question of redwood reforestation and will serve in the furtherance of this work by the various agencies that are now so ably carrying it forward. This committee consists of Major David T. Mason, forest engineer, Professor Walter Mulford, head of the Department of Forestry, University of California, and Dr. D. T. MacDougal of the Coastal Laboratory of the Carnegie Institution at Carmel. Each of these men is an expert in some phase of redwood reforestation and the investigations carried on under their direction will be apportioned among them and the results made available from time to time.

While the Save the Redwoods League has since the beginning concerned itself primarily with the acquisition and deeding to the state of tracts of original redwood forest to be set aside for park purposes, it has always been one of the objects of the League to aid in the replenishing of the supply of redwood through the support of scientific reforestation.

At the first general meeting of the League when our present aims were outlined, I took the liberty of presenting the suggestion that the Save the Redwoods League should not concern itself merely with securing tracts of lands for parks, but its objective should be sufficiently wide to include realization of the highest uses of redwood forests. To this end I proposed that we devote some portion of our energy to urging reforestation as a means by which future generations would have a large part of the redwood region available under forest conditions in addition to the small areas of primeval forest. In the course of the past three years the development of reforestation programs, initiated in large measure by the lumber interests, seem to me to represent one of the most important advances in the saving of the redwoods, and we have changed

the fifth plank of our platform from "urging" reforestation as it stood originally to "supporting" reforestation. That the initiative has been taken largely by individuals and corporations concerned with lumbering operations is extremely gratifying. In the last analysis it is the interests immediately concerned which are most favorably situated for effective advancement of such reforestation.

In the present state of development of a reforestation program it seems clear that in certain areas a new crop of trees may be grown with comparatively little difficulty in less than fifty years to such a stage as will permit a comparatively large return of board feet per acre. Satisfactory furtherance of such plans from the commercial point of view will, however, require the expenditure of considerable sums in securing stock adequate for replanting needs and in providing protection of the reforested tracts.

For other areas the possibility of reforestation on such a scale and with such limits of expenditure as to make it commercially profitable, remains yet to be demonstrated. There are many questions relating to selection of stock, the nature of general environmental conditions such as the character of the soil, humidity, temperature, and other factors controlling the growth of trees; regarding which we must have considerable additions to the information now available before it will be profitable to invest such sums as would be necessary for reforestation on an extensive scale. Much as in the case of many great industries which have grown out of the intimate investigation of certain fundamental physical, chemical or biological principles, it seems probable that the future of reforestation, not only in the redwood forests but in those consisting of other types of trees, will depend upon minute and intensive investigation of principles which have not up to the present time been fully studied.

Just in proportion as it seems desirable that we should save great redwood forests to furnish us with a future lumber supply, to protect drainage and to meet future recreational and aesthetic needs, it seems to me desirable that the League devote attention to the furtherance of investigations which will promote the progress of plans for reforestation. Researches in this field would naturally be conducted by the Federal Forest Service, by universities, by independent forest engineers, and by the corporations. There are large fields which have not been covered by these agencies and cannot be covered by them at the present moment. I am convinced that the League could perform a great service by giving

its assistance in the furtherance of such work until thoroughly adequate means for such investigations are developed by other agencies. To this end the Save the Redwoods League has expressed its approval of the support of such researches as may be necessary in the immediate future for furtherance of the work of reforestation in the redwood areas, and has appropriated a sum of money for the support of such work during the coming year. It has appointed a committee of three, consisting of Major David T. Mason, Professor Walter Mulford, and Dr. D. T. MacDougal, which will give consideration to these questions and formulate plans for action to be recommended to the League. It should be understood that such support as is furnished by the League will be advanced only where other existing agencies are unable to care for problems proposed, and that wherever possible the work to be conducted will be carried on through existing institutions competent to conduct the necessary investigations. The Committee has been asked by the League to consider and to act as early as possible upon plans for the study of:

1. The selection of redwood stock most fitted for reforestation purposes.

2. The investigation of the redwood root system and its physiology.

3. A consideration of the physiology of tree growth and wood tissue production in the redwood.

SPRUCE BARRENS AND SHEEP GRAZING

By Earl W. Loveridge

The great amount of discussion which has taken place in the Southwest as to the damage done to reproduction by animals, especially sheep, has been confined almost exclusively to the yellow pine type which represents a diminishing percentage of the total stand as the forests farther north are considered. Here, in most localities, yellow pine reproduction is not difficult to establish and although the sheep danger has been recognized, it is no longer the major management problem.

On the Carson in northern New Mexico, used here as an example of conditions on several other forests, more than half of the potential sawtimber area is in the spruce type. The balance, which should produce yellow pine, is now under control so far as sheep grazing is concerned and reproduction as a rule is being obtained. Up where the spruce has been and ought to be, however, tremendous areas of old burns and parks which are not restocking have been noticed for years by foresters and in 1920 a report by Cooperrider[1] pointed out that too heavy stocking for the good of the range and poor grazing management had been practiced. Agitation to get the fact generally recognized that the spruce barrens are not coming back is needed and at once, to avoid disastrous consequences and a repetition of yellow pine reproduction history in this type.

The general nature of the spruce country is well known to most field men but the effect sheep grazing has on the spruce seedling crop has not received the emphasis it deserves. Local observations with this point in view have only extended over the past two years and are not supported by sample plot counts and other desirable long time research methods. The fenced, closed-to-sheep, Tierra Amarilla Grant range adjacent to the forest has, however, furnished an area to contrast with the heavily sheeped forest range. On both areas clumps of seed trees are scattered here and there amidst the burns and on the edges of parks. On sites of such character are found:

[1]A Grazing Management Plan for the Carson National Forest. C. K. Cooperrider, 1920.

On the Forest Sheep Range	On the Grant Cattle Range
(1) Practically no spruce reproduction.	(1) Spruce reproduction is coming in on the old burns and encroaching on the parks.
(2) Such spruce seedlings as have survived are trimmed and pruned up like ornamental shrubbery—the rule not the exception.	(2) Some of the spruce seedlings have been deformed by cattle grazing but most of them are uninjured.
(3) The smaller groups of seed trees are trimmed of the lower branches to a height of three to four feet.	(3) Less damage — in many groups no damage—done to the lower branches of the older trees.
(4) Beneath logs where protection from grazing is obtained seedlings survive and in the midst of *large* stands of spruce where there is no incentive, feed or shelter for sheep, reproduction is always good.	(4) Same results as on Forest.
(5) Where heavy reductions have been made in the number of sheep grazed and early grazing also discontinued, the released appearance of the seedlings mentioned in (2) is striking. The ornamental effect has been lost with the leaders putting on as much as twelve inches of growth each year.	(5)
(6) Aspen reproduction under old aspen stands is lacking over large areas or where found it is often badly damaged by grazing.	(6) Aspen reproduction is becoming so dense under old aspen stands as to worry the cattle owners considerably.
(7) The forage crop has been closely utilized but not so heavily as to start a break in the ground cover.	(7) A much similar degree of utilization as on the Forest.

On the Forest Sheep Range	On the Grant Cattle Range
(8) The forage stand varies from cienegas to ridges covered with short grasses and to heavy bunch grass stands, with no difference noticeable in the reproduction.	(8) Similar forage types as on Forest.

Economic conditions in the past with the country depending on the sheep industry for its livelihood and with thousands of sheep needing summer range kept the entire field force busy, so handling the stock that the range was not severely damaged and in this they believed they were successful. The ground cover was and is in good condition and as long as it remained so it was reasonable to believe that sheep would prefer forage plants to spruce seedlings and that the lack of reproduction was due to other factors such as few seed trees, severe climate, heavy sod, soil conditions in parks, etc. This belief was further borne out by the forage which was apparently in good shape each fall due, no doubt, to the richness of the soil and abundance of rainfall; in good shape in spite of the fact that the stock followed hard on the disappearing snow banks and reached the spruce type before the grasses were established and while the spruce seedlings were the only green spots to invite their attention. It seems reasonable, therefore, to charge to premature grazing a heavy share of the damage.

Some administrative recognition has also of late been given the fact that sheep damage the seedlings at other times during the grazing period. Heavy reductions in the numbers grazed in the high country have been made to meet the grazing studies recommendations. The interesting result is that the year lighter stocking and seasonal grazing were instituted, is apparent even to the casual observer by the occasional three to four year old spruce seedlings, and particularly by the saplings, the leaders of which have been undamaged since the reductions and at last have been able to reach out at the rate of ten or twelve inches a year. Those fresh, trim shoots rising from the remains of an overgrazed past! I wonder how our modern impressionists would paint them! The picture should be enthused over for it shows there is still a chance for regenerating these lands by natural means.

Total exclusion of sheep does not seem to be indicated as essential but lighter stocking alone too often means non-use of the more inaccessible part of the range and continued heavy feeding on the open parks.

Lighter stocking with sheep and proper distribution of them together with enough cattle grazing to reduce root competition in the coarse grass types should give the young spruce forests a chance. Absolute assurance on this point can be obtained only by continued observations which will be carried out on fenced and unfenced quadrats to be established this year. Their location in relation to seed trees, forage stand, grazing use, existing reproduction, former stand, aspen growth, and other factors will, of course, be of the greatest importance and will take considerable time, but the area of unstocked potential spruce producing land is so great as to justify establishing the plots without further delay.

Pending the outcome of more intensive investigations, the observations made to date lead to the following recommendations for management of the non-stocked burns and parks in the spruce type:

(1) Avoid early grazing.

(2) Spread sheep reductions over the entire range so that the number under permit will be so scattered as to do little damage. Restock with cattle.

OR

(3) Classify the non-stocked spruce country into two types: (a) Devoid of seed trees, (b) with seed trees—even though scattered and very young. As reductions in sheep are made, concentrate them in Type (a) and remove all sheep from Type (b). Replace with cattle.

NOTES ON GROWTH OF RED SPRUCE IN FRANKLIN COUNTY, MAINE

By A. B. Recknagel,

Professor of Forest Management and Utilization, Cornell University

During April, 1924, opportunity was afforded the writer through the courtesy of Finch Pruyn & Co., Inc., of Glens Falls, N. Y., to make some measurements on the growth of virgin spruce and balsam fir in Township No. 1, R. 7, west of B. K. P., Franklin County, Me. This township lies south of Skinner, Me., a small sawmill settlement on the Canadian Pacific Railway. Within the township there are 4,836 acres of virgin timber in the spruce fir type. The elevation is about 2,500 feet. The drainage is northerly into the South Branch of Moose River which flows into Moosehead Lake.

At the time of making the measurements the snow was about four feet deep. All the work was done on snow shoes. The instruments used were a diameter tape, a Forest Service hypsometer, a fifty-foot tape and a ten inch Swedish increment borer; 83 measurements were made on red spruce, 14 on white spruce, 28 on balsam fir, a total of 125. The white spruce and balsam fir data were insufficient to permit of drawing conclusions therefrom.

The red spruce data were worked up in the customary manner.[1] The local heights were applied to the volumes given in Table 38, Bulletin 544, U. S. D. A., "Red Spruce" by L. S. Murphy.

Pressler's formula[2] was used in computing the current annual increment percents.

TABLE I

Local Heights and Volumes

RED SPRUCE

DBH (ins.)	Height (feet)	Volume (cu. ft.)
6	28	1.5
7	35	4.0
8	40	7.0
9	45	10.5
10	50	14.5
11	54	19.0
12	58	24.0

[1]See "Growth of Spruce and Balsam in the Adirondacks." Journal of Forestry, October, 1922. Vol. 20, No. 6, pp. 598 to 602.

[2]See "Forest Management," Recknagel and Bentley, Wiley and Sons, N. Y., 1919, p. 110.

TABLE I—Cont'd.

Local Heights and Volumes

RED SPRUCE

13	61	28.5
14	64	35.0
15	67	42.0
16	69	48.0
17	71	54.0
18	73	61.0
19	75	71.0
20	76	78.5
21	77	90.0
22	78	100.
23	79	
24	79	
25	80	
	(Values read from curve.)	(Vols. from Table 38 Bul. 544, U. S. D. A. Red Spruce: Murphy, 1917)

TABLE II

Years Required to Grow Last Inch in DBH and Corresponding CAI Percent

RED SPRUCE

DBH (ins.)	Years to Grow last inch in diam.	Current annual increment percent (Pressler)
6	18	3.4
7	17	3.1
8	16	2.8
9	15	2.5
10	14	2.2
11	13	2.0
12	13	1.8
13	12	1.6
14	12	1.4
15	12	1.3
16	12	1.1
17	12	1.0
18	13	0.9
19	14	0.8
20	14	0.7
	(Values read from curve)	(Values read from curve)

THE VALUE OF A TREE

By N. L. Willet

The other day at Aiken, S. C., some seventeen miles from my home at Augusta, Ga., I ran into some data as regards the value of a tree that I think worth publishing and here it is.

Possibly the most beautiful tree and the largest in Aiken was a well-known big oak down near the depot. The city authorities and the paving contractors thought that this tree was in the way of certain paving—but from which opinion a great number of Aiken's citizens radically disagreed. The tree was condemned and its death sentence was pronounced. It had to come down in all of its beauty, its usefulness, and in all of its soundness—though perhaps it was one hundred years old.

Now what this tree was made up of was five cords of wood in the top and its bottom end was a cut thirty-five inches in diameter upper end, and sixteen feet long and estimated to contain nine hundred and sixty-one board feet, and worth as sawed plank about fifty-five dollars. But in spite of this the paving contractors did not seem to know that a big oak tree was even worth its cutting. The tragedy side of the story is that Aiken city lost a beautiful and irreplacable tree that was really not in the way of paving. The contractors lost fifty dollars for they paid this sum to a certain negro to cut down the tree, remove it, and also remove the stump.

On the other hand the negro who did the cutting got fifty dollars from the paving contractors. He cut up and sold the top for firewood and stove wood for fifty-five dollars and sold the sixteen foot long lumber log three feet in diameter to a lumber company for five dollars—they digging up and removing the stump free. The negro was thus actually in pocket one hundred and ten dollars on the transaction.

We see, therefore, here that the tree had a trunk worth in board feet more than fifty dollars and had a top worth as firewood also more than fifty dollars; or in other words, the tree itself carried an intrinsic value of over one hundred dollars.

Few of us, alas, there are, who know the value of a tree—dead or alive! Many there be among us who would do well to take lessons in the tree from this Aiken, S. C., negro wood cutter.

SMALL RODENTS AND NORTHEASTERN CONIFERS

By Albert V. S. Pulling,
N. Y. State College of Forestry

For a number of years I have been devoting some time to the relation of rodents to the forest. A complete report will be published in time, but the available information is obscure, and the time has been limited. This brief discussion—a mere preliminary report—will be limited to rodents of the squirrel size and smaller. Only their effect on conifers in the northeastern softwood region will be considered. Observations have been all too casual, for they have been incidental to other work. But they have extended over several years in New Brunswick, about two years in New Hampshire, a year in Vermont, and a few shorter periods in the Catskill and Adirondack regions of New York, and in several sections of Quebec.

Red squirrel relation to pine first attracted my attention in the early fall of 1913. I was alone for a number of weeks in the Catskills, near Tannersville. There was quite a little scattering, weevil bitten white pine in the vicinity, and the section seemed healthy for squirrels. It was only a fair seed year for pine, but about September first, the squirrels began to cut off cones. They cut them *all* off in a couple of days, and spent the rest of the fall in shelling out the seeds.

That is an average sample of squirrel work in scattering pine. In a heavy seed year, they do not get them all. In a season when there is a heavy beechnut crop or an abundance of other seeds there seems to be some movement toward this other food, and a corresponding decrease in attention to pine cones. Observations in 1916 on the Lake Tarleton Club property, near Pike, N. H., showed that there was no reproduction from big seed pines on any years except good seed years, yet the pines produced some seed each year. By particularly watching individual trees, I noted that squirrels cut off every cone days and even weeks before they would normally open.

Even during a good seed year squirrels may do a hundred percent job on white pine, I was in a fine place to observe squirrels during the summer of 1924 in the woods above Little Squam Lake in New Hampshire. This year they began on pine cones on the twenty-ninth of August. It was a pretty good seed year. There was one fairly well formed white pine seed tree about thirty yards from my shack. I did not have time to count the cones, but they went into the hundreds. A single squirrel cut them *all* off in the morning. And he did it so fast, jumping from one cone to another, that sometimes two cones were in the air at one time. After a few minutes of this frantic work, he would take a rest and go at it again. The season was not advanced for the date, and the cones

were very green. A squirrel is very wasteful with his food, of course, and only a small percentage of the cut cones would ever be shelled out, but green cut cones, under the parent tree, have less show of germinating than shelled seeds that the squirrel carries away and caches.

In a good seed year, the red squirrels activity *may* plant some seeds. They keep on working as long as cones are available. They bury many seeds that they forget about, and that may germinate. And they may carry seeds or cones to considerable distances, giving them as much chance as if they were windsown.

Squirrels have much the same effect on spruce as on white pine, but on a less extensive scale. So far as I know, they rarely do a complete job on any coniferous tree except white pine, but at times approach it closely with scattering spruce. But in the case of smaller cones, smaller rodents than squirrels may be important.

Relative to spruce, one of the most important rodent problems is their possible connection with the predominance of balsam fir reproduction over spruce. There is much reason to believe that large stands of pure balsam assisted materially in making the last bud-moth outbreak more severe especially in Eastern Canada. Since lumbering has upset the balance, fir is reproducing faster than spruce. Many reasons are given for this. Rodents may be one of them. Of course fir cones ripen and fall to pieces early in September. The seed is dispersed all at once, and at a time of year when food is plentiful. The seeds rattle down into the duff, and are well hidden in a few weeks. In the case of spruce the cones opening later at a time when food is scarcer, and letting out the seeds a few at a time, small rodents may pick up all the seeds at night that fell during the day, and keep at it every night while seeds continue to fall.

There is little proof for this theory thus far. A careful system of rodent trapping combined with exact silvicultural data could prove or disprove it in time, but it will take a good many years.

The rodent problem may be quite without limits. If we definitely prove certain severe damage we may then be able to advise reducing rodent numbers. We dare not advise extermination of *anything* just now. The extermination of certain predaceous animals and birds has been advised in the past and that may be one of the reasons why rodents are doing damage now. The status of large rodents, though subject to endless discussion, is much simpler than that of the red squirrel and smaller. I think our present duty is to study every possible angle, and eventually be able to make a plan that will improve the badly upset balance rather than scramble it into even more hopeless confusion.

REVIEWS

"Tree Habits—How to Know the Hardwoods," by Joseph S. Illick. Published by the American Nature Association, Washington, D. C. 337 pp. with 140 photographic figures and 55 line drawing plates.

This is a popularly written book that will go far to help along the rapidly growing public interest in our trees and forests. It is more than a dendrological catalog of our hardwoods, as it tells of the peculiarities of the various species in a most readable way. It is one of those rare popular science books that has not sacrificed its scientific value to put it in readable form.

There are enough illustrations of leaf, bud arrangement and leaf scar, blossoms and fruit in each genus to show generic characters.

The synoptic tables showing the distinctive things to look for in telling one species from another in the same genus, is a development that is most effective in teaching tree lovers the identification of trees.

Long years of successfully teaching dendrology to forest school students have enabled the author to make this book probably the most effective volume on tree identification we have.

The reader not versed in botany may find a few omissions that might have been helpful. In the table of contents the names of the different families is not always fully descriptive to the non-botanist. Thus "The Beech Family" although botanically the *Fagaceae,* might well be called the "Beech and Oak Family" since the oaks are the widest distributed and best known genus in the family: similarly the "Rose Family" and "Pulse Family" could have been given a more inclusive heading.

Although the book is complete in including the less well known western hardwoods it gives little illustrative material on these species. To keep the book in reasonable size and cost, this may be defensible.

The popular classifications in Chap. 17 into "Trees that have pods," "Trees that bear thorns," etc., is a helpful feature to the lay tree lover.

The many commendable features make criticism of minor points seem petty. The book will commend itself to forest schools in teaching beginners the Elements of Dendrology or "Tree Identification" as well as to the more numerous tree loving public.

A companion volume on "How to Know the Conifers" will be awaited by the dendrologist and the tree lover with expectant interest.

E. A. Z.

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Compiled by Helen E. Stockbridge, Librarian, U. S. Forest Service.

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NOTES

CANADIAN SOCIETY OF FOREST ENGINEERS

The sixteenth annual meeting of the Canadian Society of Forest Engineers was held in Montreal in January last with some 60 foresters in attendance. The Secretary's report showed a total membership in the Society of 183, of whom 28 were elected in 1923.

Clyde Leavitt was elected Chairman and handled the programme admirably. The question of having a certificate or Society emblem was first discussed and a committee appointed to look into matters of cost and design. The pulpwood embargo question was then broached by Ellwood Wilson and warmly discussed, but the meeting decided against placing the Society on record thereon.

Schierbeck then urged that the Society establish an organ of its own, but the concensus of opinion was against, because of it being too costly. The incoming Secretary was instructed to obtain both technical and popular articles from C. S. F. E. members for publication in the "Journal" or elsewhere.

Ralph Hosmer, Dean of the Cornell School, after extending cordial greetings from the Society of American Foresters, asked cooperation in the general task of collecting historical data germane to the early days of forestry effort on this continent. It was decided that the President and one other should act as a committee in this matter.

Sir William Sefton Brancker of the British Air Ministry then spoke on "Air Patrol" and offered to cooperate with the Dominion Government in designing new types of aircraft, to meet the foresters' needs. After discussing specifications, two new types were decided on and by a strong resolution the Dominion Government was urged to cooperate with financial support.

In the afternoon a series of papers were presented dealing with the two outstanding questions on the agenda: The Prevention of Forest Fires and Silvicultural Problems in Management.

These excellent papers were as follows:

W. M. Robertson—"Extensive vs Intensive Research in Silviculture."

G. A. Mulloy—"Selection of Sample Plots."

Col. H. I. Stevenson—"Slash Disposal by Burning."

C. R. Mills—"Forest Fire Protection in Ontario."

L. S. Webb—"Principal Forest Fire Hazards in New Brunswick."

Prof. B. E. Claridge—"Silviculture Requirements for the Maritime Provinces."

H. R. Wickenden—"A New Method for Estimating Timber."

Arthur H. Graham—"The Fire Hazard in Quebec."

Henri Roy—"The Quebec Rangers' School."

At the afternoon session, O. C. Pease also voiced the keen concern of the Canadian Manufacturers' Association in forest conservation and promised their hearty cooperation in this most necessary work.

In the evening Mr. Barnjum tendered the members and guests a very enjoyable dinner at the Ritz Carlton. In his address of welcome, he deplored the havoc being wrought by the many destructive agencies in our forests. Dean Hosmer gave the address of the evening on "The Extent to Which Silviculture is Practicable under Present Conditions." He defined the basic factors involved as: maintaining the principle of successive crops; ensuring cordial cooperation among the interests concerned, conditioning practice on research; adequate fire prevention, and management under a flexible working plan. "Keep your eyes on these big objectives," he urged, "and the details will fall into place."

The ballots counted at the morning session, showed the following members elected to hold office until the end of 1926:

President

Dr. C. D. Howe, Dean of College of Forestry, Toronto, Ont.

Vice President

G. H. Prince, Provincial Forester, Fredericton, N. B.

Secretary

James R. Dickson, Dominion Forestry Branch, Ottawa, Ontario.

Treasurer

Clyde Leavitt, Board of Railway Commissioners, Ottawa, Ont.

DISTRICT EXECUTIVE COMMITTEES

Quebec and Maritime Provinces

G. C. Piche, Chief of Forest Service, Quebec, Que.

G. H. Prince, Provincial Forester, Fredericton, N. B.

Ellwood Wilson, Laurentide Co., Grand Mere, Que.

Ontario

Dr. J. H. White, Professor of Forestry, Toronto University, Tor.

Roland D. Craig, Dominion Forestry Branch, Ottawa, Ont.

B. F. Avery, Spanish River Pulp & Paper Co.,
Sault Ste. Marie, Ont.

Prairie Provinces

C. MacFayden, District Forest Inspector, Prince Albert, Sask.
D. A. Macdonald, Dom. Forestry Branch, Winnipeg, Man.
C. H. Morse, District Forestry Inspector, Calgary, Alberta.

British Columbia

H. R. Christie, University of British Columbia, Vancouver, B. C.
L. R. Andrews, District Forester, Vancouver, B. C.
P. Z. Caverhill, Chief Forester, Victoria, B. C.

RE-SEEDING EXPERIMENTS IN NEW BRUNSWICK

A grant of $5,000.00 per year for three years was made in 1923 by the Canadian Council of Scientific Research to the Provincial Forest Service of New Brunswick, for the purpose of conducting seeding experiments on burned-over and cut-over forest land in that province. The Dominion Forest Service is cooperating in this project.

As a start, some 60 acres of recent brulé was seeded up in 1923 by the seed spot method, the species used being white, red and jack pine. The object is to discover the most satisfactory methods of reforesting such areas and in due course practical knowledge of the highest value will undoubtedly be secured and made available.

The Provincial Forest Nursery at Fredericton is being completed this spring and is expected to serve many useful purposes. The total area of 2½ acres is expected to yield about 175,000 young trees a year, and the area can later be increased to allow an annual output of 2½ millions.

Canada has now a forest tree-seed extraction plant in the East as well as in the West. Last fall a 1½ story building was erected for this purpose at the New Brunswick Forest Nursery Station, Fredericton. It has a storage capacity of 200 bushels of cones, and an actual extracting capacity of 30 bushels per day. Any kind of cones can be treated, and in good seed years it is intended to extract large quantities of seed as a source of revenue.

Otto Schierbeck has accepted a position with Mr. Frank J. D. Barnjum with headquarters at Annapolis Royal, N. S., where he will have charge of a 15,000 acre forest and a large nursery. Furthermore, through the public spirit of his employer, Mr. Schierbeck's advice and services have been made freely available to all the timberland holders of the province.

Members will regret to learn that J. J. Guay of Price Bros. Co., has been obliged by ill health to discontinue forestry work.

Of keen interest to foresters in Canada is the fact that the Ontario Forest Service recently purchased 13 aeroplanes. Under Captain Maxwell's able control these machines will be used to patrol 60,000,000 acres of forest land as well as work on reconnaissance surveys when the weather permits. Good luck to all concerned in this progressive step toward effective protection in the banner province.

F. T. Jenkins recently left the Ontario Forest Service in order to join the James D. Lacey Company's new Air Service, with headquarters in Montreal. In our friend Jenkins, this Company have added to their staff one of the most expert forest observers on the continent.

Loren L. Brown is representing the British Columbia timber interests at the Wembley World's Fair.

Through stress of work last winter, Dean Howe overtaxed his strength and has been obliged to take a semi-holiday for a time, but we are glad to report, has now almost recovered.

Our old friend, Hugo C. Wallin, writes that his work in Sweden involves much pleasant travelling about from forest to forest, but that the business outlook in the forest industries of that country still leaves very much to be desired. Sometimes he wishes he were back in Canada.

The reorganization of forest administrative affairs in Quebec, consequent on the passage of the new Provincial Forest Law, has resulted in the appointment of Henri Keifer as Chief of the Fire Protection Service. Keifer, who has been an official of the Quebec Dept. of Lands and Forests, for 16 years, will enjoy complete control of this service at a salary of around $5,000.00.

An interesting article by Mr. Barnjum appeared in "Toronto Saturday Night" of May 3rd. He urges the Canadian Society of Forest Engineers to take its proper place in the life of the nation, in the moulding of public opinion, the framing of forest policies, and in securing equivalent recognition and remuneration with other classes of engineers engaged in directing the development of the nation's resources.

R. D. Jago has severed his connection with the New Brunswick Forest Service to accept a position with Price Bros. & Co., Ltd. W. M. Robertson, recently appointed Chief Forest Surveyor in charge of Research in the Dominion Forest Service, has just returned from Quebec and New Brunswick and intends going west shortly to organize research work in the various districts.

It has been decided to place three national forests, Sandilands, (Manitoba), Nisbet, (Saskatchewan), and Cypress Hills, (Alberta), under definite working plans, and the necessary surveys are being made this summer.

The Dominion Forest Service has prepared a manual for forest research which is now in the hands of the printer. This will fill a long felt want and do much toward standardizing research methods in Canada.

All goes well at the Toronto School. The new building, to be a fine structure about 60 x 70 feet in size with 4 floors, is practically assured. It will be located on St. George Street. Among the 13 graduates of the year, three are employed by Ontario and 2 by the Dominion, while four are in private forestry work. Of the 30 undergraduates, 18 are employed this summer by the Ontario Forest Branch, 3 by the Dominion, 6 by private companies and 3 are not seeking work.

F. A. Gaylord, recently forester for the Ne-ha-sa-ne Park Association, is now manager of the Woodlands Dept. of the A. P. W. Paper Co., at Sheet Harbour, N. S. Mr. Gaylord has just been elected an active member of the Canadian Society of Forest Engineers.

In New Brunswick, Col. T. G. Loggie, Deputy Minister of Lands and Mines, has geen granted a year's leave of absence and our popular Vice-President, G. H. Prince, is now Acting Deputy Minister. L. S. Webb is acting as Provincial Forester.

It is reported that Professor A. V. S. Pulling of the University of New Brunswick has resigned to accept a position at the Syracuse forest school, New York.

Professor B. E. Claridge is also leaving Fredericton this month to manage the Woodlands Department of the Hammermill Paper Co., with headquarters at Matane, Quebec.

Professor W. N. Miller of Toronto, will be busily engaged this summer conducting a field investigation for the Dominion Fuel Board on the use of wood for fuel.

OBITUARY

The death of *Thomas Southworth* on March 12th, last, was cause of deep regret throughout the Society. For many years he has been an honorary member, and in former days, when Director of Colonization in Ontario, he did yeoman service in behalf of sane and effective measures of forest conservation. He was one of the Charter

Members of the Canadian Forestry Association. Of late years, however, his energies were devoted very largely to his wide business interests.

HENRY DANA JEWETT

The late Mr. Jewett, was burned to death, together with his two infant children, in a fire which destroyed his home in Iroquois Falls, on March 31st. On returning from Overseas in 1919, he became Associate member of the C. S. F. E., and in recent years has been employed as a logging engineer by the Abitibi Power and Paper Co. On behalf of the C. S. F. E. a letter of condolence was sent to Mrs. Jewett, expressing sincere sympathy and regret.

—J. R. Dickson.

SOCIETY AFFAIRS

ANNUAL MEETING OF 1924

Preparations for the annual meeting are under way. The decision to hold it in Washington, on December 30 and 31, permits a fortunate coincidence with the 79th meeting of the American Association for the Advancement of Science and the associated societies of which this is one. More than 30 organizations have signified their intention to hold meetings at Washington during the convocation week of the Association, from December 29, 1924, to January 3, 1925.

Since the Society was founded on November 30, 1900, the meeting will occur in its 25th year, and the Committee on Meetings has this fact in mind in planning the program. In the words of Major D. T. Mason, Chairman of the Committee, "It is the general plan to treat this meeting as the quarter century mark in the history of the Society. We shall take a look back to see what has been accomplished to date, and also a look ahead to see what we ought to do in order to direct the development of American forestry in the right channels." It is hoped that there will be not only an exhibit sponsored by the Forest Service, but the presentation of motion picture films of interest to the members and their friends.

On the evening of December 31 a banquet is to be given by the Agricultural Section (Section O of the Association) which visiting foresters are invited to attend. Members who are prepared or who desire to submit timely and suitable discussions for use in connection with the meeting would do well to communicate with Major D. T. Mason, Northwestern Bank Building, Portland, Ore.

Chairmen of all standing committees are expected to be prepared to report to the meeting. All secretaries of Sections are requested to write to the general secretary giving an estimate of the number of members from their Section who will probably attend.

Rates are quoted by 29 hotels, ranging from $2.00 for a single room and $4.00 for a double room, up to $5.00 and $9.00 for single rooms, double rooms $7.00 to $12.00. At some of the best known hotels, such as the Harrington, Raleigh and Willard, rates range as follows: Single rooms, $3.00 and up; double rooms $4.00 and $5.00 and up. The Harrington will be the general headquarters for the meeting.

Reduced railway rates on the certificate plan have been granted to those attending the meeting from all parts of the United States and

from points in Canada east of, and including Armstrong, Fort William and Sault Ste. Marie, Ontario. The return fare under this plan is one-half the regular rate. The reduction does not apply to Pullman fares. Details will be furnished to members later, with the program.

SPECIAL MEETING OF THE EXECUTIVE COUNCIL

Owing to the considerable number of matters, important to the welfare of the Society, and which can not be well decided by correspondence, President Mulford has called a special meeting of the Executive Council to be held in Washington December 28 and 29. All members of the Council are urged either to be present at the Forest Service at 9 a. m., December 28, or to lodge a proxy with some member who is certain to be present.

At least 35 societies will be holding their meetings in Washington during the last week of December and the first three days of January. Our own program will be very full of interesting topics. Hence those visiting members who are interested to attend the meetings of other societies or the exhibit of research methods and scientific apparatus to be established by the American Association for the Advancement of Science would do well to spend a day or two in Washington additional to those occupied by our meeting.

Program for Annual Meeting of the Society of American Foresters, to be held in Washington, D. C., December 30 and 31, 1924.

There will be four sessions of three hours each, beginning at 9:30 in the morning and 2:00 in the afternoon. At the beginning of the first session, and toward the end of the last session, time will be devoted to various business matters of the Society.

On the evening of December 30 there will be an informal dinner and smoker for members of the Society, or else motion pictures under the auspices of the Forest Service.

On the evening of December 31 there will be a joint dinner with members of Section "O" of the A. A. A. S.

The meeting will be devoted to consideration of—

"In the field of forestry, what has been accomplished during the first quarter of the 20th Century, and what shall we seek to accomplish in the second quarter?"

The purpose is to survey broadly the field of forestry; to set forth what has been done during the past twenty-five years; what progress has been made; in what direction we are now moving; what changes, if any, should be made in the course ahead; and by what

means we may best reach the objectives which should be set for attainment by the middle of the present century.

The idea is to deal with the whole field of forestry, but incidentally, and without forcing the issue at all, to point out briefly in appropriate places what influence, if any, the Society of American Foresters may have had in developments up to this time, and in what way it should, as a society, exert its influence in the future.

As the result of various recent developments, it is quite evident that we are about to enter upon a new phase of forestry in the United States. Therefore, it is especially appropriate to undertake to define where we stand at present and to make plans for the guidance of future developments in the field of forestry. President Mulford has suggested this subject for the annual meeting in the belief that the meeting can be made one of great importance in the history, not only of the Society, but also of the progress of forestry in America.

The program includes the following subjects:

December 30. *Morning Session*

"The Society of American Foresters." (President's address.)
"Forest Protection—Insects."
"Forest Protection—Diseases."
"Forest Protection—Fire."

Afternoon Session

"Forest Products Investigation."
"Forest Experiment Stations."
"Forest Mensuration."
"Silvicultural Practice." (This subject includes planting.)
"Range Management."

December 31. *Morning Session*

"Tax Legislation as Related to Forestry."
"Forest Management on Federal Lands."

(This subject would include not only the policy followed by the Federal Government in setting aside various lands as National Forests, or providing forest management of some sort on other lands not included in National Forests, and future development along these lines, but also the policy followed and to be followed in acquiring additional lands not owned previously by the Federal Government; also various phases of management—for example,

as regulation—not more appropriately dealt with under other headings.)

"Forest Management on Privately Owned Lands."

"State Forestry."

Afternoon Session

"Timber Supply and Demand."

(Under this heading would be considered the extent to which, in various ways, our timber supply and demand have been diminished or increased, and what are the future prospects; the availability of timber in other countries for import may also be included.)

"Public Sentiment with Relation to Forestry."

"Forest Education."

SUMMARY

of an investigation into the status of paid secretaries of technical societies.

1. Number of members:
   - 2 under 1,000
   - 3 under 10,000
   - 4 over 10,000
2. Annual income:
   - 2 under $10,000
   - 1——$50,000
   - 1—— 90,000
   - 1——100,000
   - 4——200,000—$500,000
3. Annual dues:
   - 1——$4
   - 1—— 5
   - 1——10
   - 6——15—$25
4. Years paid secretary has been employed: 10-52 years.

	Years a paid Sec. has been employed	Number of members	Annual budget	Annual dues
Geological Society of America	over 10	507	$5,000	$10
American Institute of Chemical Engineers	14	600	90,000	18 and 12
Society for the Promotion of Engineering Education	10	2,000	8,000	4
American Society for Testing Materials	22	3,400	50,000	15 and 7.50
American Institute of Mining & Metalurgical Engineers	50	9,081	100,000	15, 12 and 6
American Society of Civil Engineers	52	11,000	300,000	25 and 10
American Chemical Society	25	14,500	200,000	15
American Institute of Electrical Engineers	40	15,403	500,000	20, 15 & 10
American Medical Association	over 10	90,000	350,000	5

K. N. Woodward

Sept. 27, 1924.

May 10, 1924.

The North Pacific Section has just completed a series of well attended open meetings. Every effort was made to interest lumbermen, timber owners and all those connected with the forest industry to attend these meetings and enter into the discussions. The response has been gratifying. The meetings were held in Portland, Oregon, as follows:

December 21, 1923. E. J. Hanzlik of the U. S. Forest Service spoke on "Forestry and Lumbering in Sweden."

January 25, 1924. E. T. Allen of the Western Forestry and Conservation Association spoke on "Proposed Forest Legislation." A. W. Cooper of the Western Pine Manufacturers' Association discussed "The Encouragement of Private Forestry." T. T. Munger of the U. S. Forest Service had as his subject "The Extension of the National Forests."

February 29, 1924. This meeting was devoted to a discussion of what private owners are doing in practical forestry. J. A. Watzek of the Crossett Lumber Company and Jackson Lumber Company discussed the southern yellow pine region from the forestry standpoint. J. M. Walker of the Crown Willamette Paper Company described the forestry work in the Douglas fir-Sitka spruce region. N. G. Jacobson of the Western Forestry and Conservation Association took the yellow pine region of Oregon and Washington as his topic. O. M. Clark of the Clark-Wilson Lumber Company spoke interestingly on his observations of forestry in Japan.

March 28, 1924. This meeting was given over to forest taxation. The speakers included Governor Walter M. Pierce, George H. Cecil of the U. S. Forest Service, Dean Hugo Winkenwerder and Professor Burt P. Kirkland of the School of Forestry of the University of Washington, Dean George W. Peavy of the School of Forestry of the Oregon Agricultural College, and Carl M. Stevens of the firm of Mason and Stevens, forest engineers.

April 28, 1924. D. T. Mason of the firm of Mason and Stevens, forest engineers, talked on recent developments in forestry in the redwood region. A. J. Jaenicke of the U. S. Forest Service spoke on pine beetle protection in Oregon and Washington with special reference to the large beetle control project now in progress in southern Oregon.

Bar Harbor, Me., September 16, 1924.

Editor:

Your note about the Editor's problem on pages 572-573 of the May number of the JOURNAL OF FORESTRY is indeed interesting. The JOURNAL is beginning to feel the pressure to which scientific periodicals have been subjected for some time. The wonder is that the available space has been sufficient to accommodate the demand for so long. Ecology has been crowded almost since it first took over the Plant World, but its resources have been much less than those of the JOURNAL OF FORESTRY. Three years ago we raised a sum by voluntary contributions, and two years ago we increased the dues of members of the Ecological Society and the subscription price. We have thus been able to enlarge Ecology by adding to the number of pages without more issues per year. But the inflow of manuscript has more than caught up with the additional space, so that we are further behind than ever on our list of papers awaiting publication. We are, however, self-supporting and will not incur a deficit again if we can avoid it.

Of the two alternatives which you propose, either making the JOURNAL a monthly publication, or raising the standard of papers accepted for publication, the first would probably require action by the Society since it involves an increase in the budget for the JOURNAL. The second, it seems to me, you or the Editorial Board could apply without further authorization since it is a matter of editorial policy. Everyone, I feel sure, understands your reluctance to set standards of your own, and appreciates your willingness to give the Society a voice in "the revision upward of our technical and literary standards." But in editorial work one man must bear the brunt of the responsibility. I doubt if any cut and dried standards would help you very much. Their application would always be a matter of personal interpretation. You, with your long editorial experience, are probably in a better position than any other member of the Society to formulate the requirements to be met by papers offered for publication. When you are in doubt about a paper you can refer it to one or two members of the Editorial Board.

As a matter of fact, the growth in production of papers which causes your problem is in itself a healthy sign. It is good for a journal to have the demand for space exceed the supply, since it permits of a

selection from the papers offered. This not only benefits the JOURNAL itself, but raises the standard of work in the entire profession.

My suggestion would be that, in future, papers be subject to more rigid selection as to substance and presentation. This cannot, of course, apply to papers already accepted. At the winter meeting you could bring up the question of making the JOURNAL monthly, and show just how much it would cost to do so. With the increasing size of the Society, and decentralizing tendency of the Sections, the JOURNAL is the strongest unifying force we possess. It seems to me that, so long as it is economically managed, it is entitled to first call on the funds of the Society.

You can print this or any part of it in the JOURNAL if you wish, but, I think it would be better to save the space for some of the many articles you have on hand.

Very sincerely yours,
BARRINGTON MOORE.

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